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The Use of Operational Gaming as an Aid in Policy Formulation and Implementation

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PREFACE

This Collaborative Paper describes the proceedings of an international workshop on the use of operational gaming as an aid to policy analysis which was held at the International Institute for Applied Systems Analysis from 29th August to 1st September 1978. The purpose of the workshop was two-fold. In the first place, it was designed to ensure an interchange of ideas and information between experts from seventeen countries supporting IIASA in a field where there has been a good deal of informal comment but little serious attempt to identify the state of the art. In the second place, it was intended as a means of advising IIASA on the desirability of establishing some continuing effort in the field of operational gaming. The paper sets out some of the more important contributions made to the conference and presents a review of the discussions which took place over the three days. The main points of argument, uncertainty and agreement can thus be easily identified, and should be of help to others venturing into this field.

Subsequent to this meeting a program of work at IIASA has been prepared (Stahl, 1979) and is now in progress.

Rolfe Tomlinson
Area Chairman
Management and Technology

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BACKGROUND TO THE WORKSHOP

R. Tomlinson

The purpose of this introduction is to explain why the workshop meeting was held and what it was expected to achieve. Before doing this, however, it is necessary first of all to say something about IIASA itself and its objectives.

The International Institute for Applied Systems Analysis is supported by seventeen nations and controlled through the scientific academies or similarly constituted bodies in the various member countries. It is unique amongst international scientific institutes for a number of reasons.

In the first place, there is no other international institute devoted to systems analysis, let alone applied systems analysis; more unique still, there were at the foundation of the institute, no national institutes in existence which were entirely devoted to the subject. This has meant that so far as program building has been concerned, there have been few examples to draw on. IIASA has thus had the freedom to develop a program for itself which implies freedom to makes its own mistakes. Its chosen mixture of interacting research fields--Energy, Food and Agriculture, Resources and Environment, Human Settlements and Services, Management and Technology, and System and Decision Sciences--has enabled the Institute to span a wide range of interacting systems problems facing the developed world, without encouraging the belief that it can in any sense be fully comprehensive.

The Institute is genuinely international with scientific staff drawn from more than twenty nations, but it recruits and deploys its staff in a uniquely flexible way. There are few long term appointments, and no posts are earmarked for any one nationality. This means that it is possible to recruit a team for work on a given problem regardless of particular constraints

on the nationality of the staff concerned excepting for the general constraint that all the teams are international and wherever possible east-west. The program can thus be uniquely adaptive to the needs of the member countries expressed through the Council.

A third unique aspect is that the control of the Institute is strictly through the scientific community and not through the governments who provide the money. This scientific independence is taken very seriously--Academies of Science are notoriously jealous of their independence and integrity! They ensure that the highest standards of internal criticism are maintained and that the work of the Institute is primarily directed towards the development of methods which can be universally applied, rather than to consultancy on purely local problems facing individual countries.

Finally, the Institute is unique in the emphasis that Council put on the word "applied". Scientific the work must be, but it must be applied science; the results must be usable, and must be derived through the practical experience of working on real problems.

Reference has already been made to the fact that there are, at IIASA, relatively few long term appointments, and in part, the existence of this workshop derives from the fact that two newly appointed area leaders were re-examining their own programs at the same time. At the time of the workshop, Peter de Janosi had been leading the System and Decision Sciences Area for only a few months and I had been responsible for the Management and Technology Area for a little longer. We were both trying to identify appropriate problems to study and anxious to develop a line of approach that would develop closer cooperation between the methodologists and the applied analysts.

One of the topics which it was felt that the Management and Technology Area should consider was the way in which systems analysis could make a more effective impact on decision making processes. IIASA was very much engaged in the development of models; how could we ensure that they could be of real practical value to analysts. One of the well-known difficulties preventing the integration of analytical ideas into the decision making process was the fact that we are still unable to adequately model the decision processes to which the analysis is to be applied. One of the few tools that has been used extensively for this, in military circles at least, is operational gaming, but the transfer of this technique to the study of civilian policy problems has not been extensive. One of the reasons for this could be ignorance on the part of those who might make use of the technique, or indeed a misunderstanding of its potential range of application. The subject is certainly not well documented, as my team in the National Coal Board found when, some years ago, it set out to develop a Game Against Nature as an aid to the planning of collieries. There was hardly anything in the literature that could help us, certainly nothing comprehensive. Because of this experience I organized a discussion session on operational gaming at the First International Discussion Conference on Operational

Research held in Oxford in 1971. To my surprise, the discussion attracted a room full of interested people but hardly any of them had real experience of gaming. I have since been able, in an editorial capacity, to encourage at least the writing of one book on the subject. Nevertheless, it seemed to me that active research was needed if the subject was to be advanced and some important questions answered. If this lack is widely felt then there is at least a prima facie case for undertaking such further work at IIASA.

But IIASA has also a methodological interest in the subject, which is potentially the field of interest of the Systems and Decision Sciences Area. Indeed, there is already a small tradition of gaming at IIASA. A game had earlier been designed by V. Sokolov and I. Zimin (1975) and more recently Olaf Helmer had designed a game known as GEM (Helmer 1979) to study international trading problems. The presence of Olaf Helmer who is an internationally known authority in the field, provided us with a firm base for considering future developments.

There were thus a number of possible reasons why we should embark on a gaming program. The first of these was simply that gaming was a tool that one would expect to be used from time to time within the Institute; it was desirable that when gaming was applicable, the skills and knowledge to undertake it was available. In the second place, and this was particularly important for the Management and Technology Area, gaming is one of the few techniques which enables analysts to incorporate unquantifiable human decision processes into their studies and which provides an interactive association between the policy maker and the analyst. It's value therefore needs an authoritative study. Finally, and this was the main concern of systems and decision scientists, part of the IIASA task is to ensure that the state of the art of the various tools of systems analysis are identified and, where appropriate, improved.

In considering how to explore the situation further, we found that the experts in the field were dispersed and the few articles on operational gaming tended to be lost either in specialized journals or combined with other less relevant forms of gaming. In fact, it was impossible to identify the state of the art from a literature search. We were also interested to find that discussions within the CMEA countries a year or two before had led to a similar conclusion, and that there were now annual meetings within those countries to discuss the latest developments in operational gaming. Clearly then, a meeting, if it was organized at IIASA would serve an immediate purpose in bringing together experts who would not otherwise meet, as well as the long term purpose of helping determine IIASA's future program.

Accordingly, we invited Professor Martin Shubik to take a lead on this and help organize a meeting of experts. We held a small task force meeting in June 1978 to make preparations for the conference, at which Shubik and IIASA staff were joined by Mr. K. Bowen and Professor V. Marshev.

The form of the present meeting is therefore the responsibility of that task force, and they deserve our gratitude.

The foregoing explains why IIASA is interested in this topic, why we have called a workshop, and what were the mechanics of its preparation. Finally something should be said about its purpose. Although the promotion of international scientific exchange of ideas and information, and indeed the development of personal relationships, is of great importance and could perhaps justify such a meeting without further cause, our motives are not so impersonal. We arranged the meeting because we needed advice. In particular we needed an answer to the question

> Should IIASA develop a field of activity in the area of gaming?

More specifically it was hoped that by the end of this meeting answers to the following questions would be available:

-- What is the current state of the art in operational gaming as an aid to policy analysis? Are we able to define the problem situations where it may be expected to be of value?

-- Is the existing literature adequate for the support of a scientist coming fresh into the field, or is there a need for a textbook or handbook on the subject? Would it be appropriate for IIASA to issue such a book in its Survey series? What form should it take?

-- Should IIASA be making more use of operational gaming in the course of its research work? If so, what are the most important areas where the technique should be applied? How could we best ensure that this work is so done with the necessary expertise?

-- Should IIASA engage on research into gaming (as distinct from using gaming as a technique)? If so, what are the particular areas where research is most needed and which is appropriate to IIASA's special environment?

In all honesty, we did not expect a consensus on all these questions during this workshop. We were, in fact, impressed by the degree of unanimity that was ultimately reached. At the time of writing, more specific proposals have been prepared, and await consideration. The desire to collaborate with IIASA, and with each other, was made very clear. The work should continue.

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STATE-OF-THE-ART SURVEY

Martin Shubik

INTRODUCTION

This is a conference on gaming as an aid in policy formulation and in implementation. There are many different aspects of gaming, but at this particular moment the stress is rightfully laid on policy formulation and implementation, especially given the nature of IIASA as an institution.

I want furthermore to stress that this conference should have both a retrospective and a prospective role. Retrospective because it is important to look at what has been accomplished and the proof we have of that accomplishment. Prospective because the important question at this conference is: Is this an art form that merits pursuing, and if it merits pursuing, what are fruitful paths to follow? Can we use our retrospective knowledge to spell out and to indicate what further developments should take place and what approaches will fail?

I wish to divide my remarks into:

-- Comments on the general context and relationship of gaming to other subjects;
-- A brief discourse on types of gaming and their applications; and
-- A discussion of the nature of gaming most directly relevant to this conference.

GENERAL CONTEXT OF GAMING

It is important first to provide a contextual reference. This is particularly relevant because one of the most dangerous gaps that exist between the practitioners and the developers of methodology and theory, in operations research in particular and the behavioral sciences in general, is that in the development of theory many of the simplifying assumptions are implicit, not explicit. The great difficulty in discourse between those with a research paradigm and those with a problem is caused frequently by the fact that some implicit assumptions made by the research worker happen to not be the implicit assumptions made by the person with the problem.

I want to contrast quite briefly three different topics which are highly related but very different. They are: Gaming, Simulation and Game theory. All of these topics have been subject to major development in the past three decades and are frequently confused.

Gaming, I believe, has its closest connections to the behavioral sciences. In contrasting it with the others I stress that gaming is people oriented. The individual plays a central role in gaming of virtually any variety. There are two features upon which gaming lays stress. One is sensitivity analysis and the other is model critique. The good gamer is always conscious of the frailties of the model and the model is up for inspection virtually all of the time.

Simulation, especially as it is done today, tends to be more computer oriented than people oriented. The size, complexity and sophistication of simulations have grown, but just because a program is large and complex really gives us no clue as to whether it is good or bad. The good or bad features have to be determined on an ad hoc examination of the particular simulation one is looking at.

The role of simulation has undoubtedly become more intertwined with econometric methods and with general planning methods. If we had had this conference 20 years ago and if you had then mentioned the word simulation to an econometrician it would have been like mentioning the Anti-Christ to one of the faithful. At present styles have changed and econometricians are working hand in glove with the simulators. The general idea of the computer as a device for manipulating very large planning models has been accepted in areas where 20 years ago they would have not even considered it.

This is not an unmixed blessing. One of the problems with the growth of computer size and the sophistication of computer technology has been that it is now possible to manipulate easily models where the low amount of critical evaluation gone into the model makes it dubious whether it was worth building the model in the first place. One of the advantages of the bad old early days of computers was that it was so hard to use a computer that if you did not specify your problem carefully

you could not get it on the computer. Nowadays computer systems are sufficiently sophisticated that it is easier to run programs with logical flaws. The system might even patch up your program. But unfortunately, although a computer may be able to patch up your program from the point of view of faulty programming, the feature that may be wrong with large scale models is not the programming logic, but the inference that went into the selection of certain aspects of the model building. As the computer is unable to walk around and look at the world yet, it is not able to correct modeling errors. Simulation, although not a prime subject, is thus of importance in the context of this conference to the extent that gaming can be seen as a debugging device for large scale simulations.

The third topic is game theory, which is oriented towards mathematical methods in the study of decision systems and is clearly related to a study of conflict and cooperation. The people who develop the mathematics of game theory are in general very different from those who work in experimental gaming and the people who do experimental gaming are to a great extent quite different from those who utilize operational gaming. In developing useful applications we have a problem in the difference between the culture or the sociology of the individuals involved in different scientific efforts. The social psychologists frequently have difficulty talking with the game theorists and the experimental psychologists have a great deal of difficulty talking with people whose bent is more managerial. At most business schools in the United States, for example, there are psychologists whose main concern is with managerial psychology and they have considerable difficulties in talking with those who are more interested in experimental psychology or operation research.

This conference is not the right place to discuss game theory or simulation but these disciplines are vital to much of successful gaming. For the remainder of this talk, I confine my remarks to various types and forms of gaming, a little history, and some comments on uses and users.

TYPES OF GAMING

I am well aware of the dangers in trying to present a taxonomy on the uses of gaming, but if utilized with scepticism taxonomies are frequently useful. One immediate use is comparing one expert's taxonomy with someone else's taxonomy to examine their differences in world view.

I will suggest five major crude subdivisions of gaming for purposes for this conference. There could be more, but further refinement does not seem worthwhile. The subdivisions that I would like to suggest to you are: 1) teaching, 2) training, 3) operational gaming, 4) experimentation, and 5) future study, i.e., structural brain storming.

Operational Gaming can in turn be split into a) policy formulation, b) dress rehearsals, i.e., actual testing out of plans, and c) gaming for sensitivity analysis and commentary on plans.

Experimentation can be divided into the two rather different, although allied topics, namely theory validation, and theory generation. Frequently in the running of a good experiment, one finds things that one was not looking for. A reason for running a formal experiment is often not to test the value of some parameter or a particular hypothesis, but to find out what happens to the system when you do not have too many intervening variables interacting at the same time. That is a far cry from the classical sort of experiment that used to be the great love of the experimental psychologists 20 years ago.

The forms of gaming are quite different in their uses. The two contrasting forms that we frequently encounter are rigid rule gaming and free form gaming.

Rigid rule gaming comes in at least two packages, non-computerized and man-machine gaming. There has been a considerable swing, in particular in the United States, towards the machine. In many instances man is being pushed further and further away as an inconvenient appendage to processes that can be simulated more expeditiously with a digital computer. I tend to not support this trend, especially in applications to management problems. As regards human affairs I believe that large scale digital computers are excellent in reducing enormous quantities of accounting data, but when one starts to generate large numbers of behavioral equations for models, I feel much more comfortable to know that every now and then some human being with experience is required to examine and to challenge these behavioral equations. In order to be able to challenge them they have to be seen. The more one hides in bigger and fancier black boxes the less is seen and the more one promotes a division between users-obtaining the oracles from the black box--and the priests of the model, i.e., those who feed the black box.

Certain types of gaming may have rigid rules although they are non-computerized, such as for example, simple production inventory scheduling games. For example, it is possible to train lower management in production inventory scheduling games using nothing more than a large board on which there are colored pieces of wood of various lengths representing the length of time to do a job, and with different colors indicating the priority of the job. Every aspect of this model is immediately visible. A shop steward can look at the configuration of the board and say "This certainly doesn't look like my shop. You must be out of your mind if you think that that's what the machine configuration looks like in our industry". Because of "game transparency" a perfectly ordinary experienced shop steward could say whether this game was of some use or not. Although the rules were rigid, the rules were understood by both the user and the person constructing them.

In rigid rule gaming one must contrast between non-computerized games which in general can be presented so that the rules can be understood fairly quickly and man-machine games where the mere fact that an individual sits down in front of a computer console means that somebody has to accept the validity of what is in the black box.

The other type of gaming is free-form gaming where the individuals constructing the game and the individuals playing the game accept as a fact of life that neither those who are constructing the game nor those who are playing the game know all of the rules in advance.

The general philosophy of free-form gaming is the very reverse of the philosophy of rigid rule gaming. The rules are meant to have some validity in rigid rule gaming. In free-form gaming the understanding, either implicitly or explicitly, is that the game is not completely known and that the playing of the game in itself will serve as a device for generating a better understanding of the rules. Immediately one should be able to see that the emphasis on the participation and quality of the individuals must be much higher in the use of free-form gaming. The value of a free-form game may be highly related to the expertise and sophistication of both the players and the referees.

One form of a serious free-form game may call for a fully organized three team structure for a two team game or a two team structure for a one team game. In general most games that are useful for planning purposes involve either one team against an environment or two teams in a situation of conflict. Military gaming is very heavily a two team game; one usually postulates an opponent; hence there usually is a red and blue team. In business gaming in general the competitive environment consists of oneself and an aggregate of the others. The others may in some business games actually be separate teams: 2, 3, 4 etc., but frequently the others are lumped together as a reactive environment. In general there are one or two teams of critical interest. There may be an extra team which consists of expert referees. In a free-form game it well may be that the most critical team is the referees. The sociologist Herbert Goldhammer was one of the early instigators of the three team game. He did it in the context of the political military exercise, but the validity of this type of game goes well beyond the military. The idea is that when you have individuals who themselves are experts studying an area, where the rules are really not known, an efficient way to organize is to have three teams: the referees and the two opposing teams. After the teams have made a move, the referees take a look at the move. The referees, being a team of experts themselves, could say "That's not really a plausible move". Then the game comes to a halt and the two teams plus the referees discuss whether the rules should permit such a move.

The purpose of such an exercise is to explore the feasibility and the plausibility of the model. To a great extent good long term planning is closely related to such a process. It is not too difficult these days to employ people to run regression analysis, to build simple simulations, to make quick statistical checks etc. The real trick is to have some faith in the model being built; that is to have some faith in the essential assumptions behind the model. The development of free-form gaming came about in an explicit recognition that frequently the problem is not how the game is played or how the model is manipulated, but the validity of the assumptions that went into the model in the first place. The question was: Is there a methodology which helps investigate the validity of the model. One might say this is the method of sensitivity analysis. It is far more. It is not just a way to check parameter values. It is an approach to the question as to whether you have the right structure for the model.

HISTORY OF GAMING

I would like to proceed with a brief comment on the history of gaming. The largest and oldest use of operational gaming has undoubtedly been within the military. The modern origin of operational gaming is usually attributed to the Prussian war staff. However already in the writings of Sun Tsu, the great Chinese General of the 5th century B.C., one can find both the concepts of operational gaming and some elements of the theory of games, at least in its two person zero sum form. This work had to wait for about 25 hundred years before anybody did anything about its game theory aspects and had to wait about 23 hundred years before anybody really took up the gaming aspects of this work.

I note the military background of operational gaming because it is important that in this conference we ask ourselves if the ways of peace can learn from the techniques which have been successfully applied to war. Why should or why should not the aspects of operational gaming be transferable to non-military problems? Is it something about the peculiar nature of war that spells out the possibility that the techniques used there really have very little to do with the techniques that can be used for peaceful planning? I believe that this is not the case, but it is something that we have to discuss more closely.

USES OF GAMING

Next I have some comments on some of the uses of gaming. In my taxonomy I contrasted teaching and training.

Frequently when one is training, one is not particularly interested in going into conceptual details with the individuals one is training. For example, in the inventory scheduling game mentioned we were not trying to convert lower management into heuristic programmers. We only wanted to illustrate some of the aspects of the scheduling problem.

The uses of gaming in training are large. At this moment, there is a large and specialized body of application not only in the West but also in the East. The uses of simple games for production or inventory control is fairly well developed. This use is sufficiently specialized and sufficiently well under control that it is not of prime concern to us here.

In teaching, as compared to training, one wishes to get across concepts and abstract ideas.

At the university level and at some of our business institutes the uses of gaming have been linked to the teaching of production, control and accounting. Although one does not use large scale business games merely to teach accounting forms, one of the great uses of large scale business games has been to call attention to accounting concepts. It is quite easy to teach people how to fill in forms, how to run production schedules and how to manage the substance of a bureaucracy. It is another thing to get them to raise pertinent questions as to why a procedure is being followed.

The use of large scale managerial business games is of concern to this conference. In the last 20 years there has been an enormous growth in the use of these games. There is virtually no major business school that does not have some use for a business game.

In the United States, in some of the larger corporations the use of business gaming at the upper managerial levels has peaked and dropped. In IBM more upper management games were played 10 years ago than today. I can speak from the experience as a builder of one of the major IBM games, the Financial Allocation and Management Game, built for the upper middle management training within IBM. Several years later it was decided to use that game for a lower level of management. The important question was: Do management games catch enough of the real problems of upper management. There was a clear concensus that the formal management games did catch enough for middle management training but there was not a concensus that they caught enough for upper management training.

This type of question has also come up in military college training. The observation has been that games at middle management level undoubtedly have a valuable role, but as to the value of games at upper management levels there is more doubt.

This distinction is closely tied in with the contrast between free-form and rigid rule gaming. The games that have been successfully used at business schools have mostly been rigid rule games, essentially large scale computerized games which spew out large amounts of data and which represent a fair amount of the bureaucratic work of the middle managerial levels but do not represent, or do not catch the flavor of the vaguer and less structured sort of conceptualizing work of the upper level of management.

More recently the type of gaming represented by the large scale management game has spread. There has been a development of urban gaming and of societal problem gaming. One of the fundamental conceptual difficulties of gaming techniques in this area has been precisely the problem mentioned above regarding middle and upper management in managerial gaming. When you try to construct games to handle societal problems, for example, slum clearance, the problem is not in the playing of the game, but in the model itself. Are we capable of conceptualizing adequately at that level to make it worthwhile building rigid rule games for such problems? I have some serious reservations. Here is the question of free form versus rigid rule gaming again.

I have a brief comment on research gaming. This is a growing and important field. The people involved frequently have very little to do with the people in operational gaming for managerial uses. In the last 20 years, there has been an enormous upswing in the performance of simple experiment in social psychology and experimental psychology. There is now a small discipline entitled experimental economics. There have been several conferences devoted specifically to work in experimental economics, where for example the experimentation on different price formation mechanisms has taken place. We now have some tentative results in this particular area. Frequently when we make assumptions about cooperative or competitive behavior they are assumptions based on casual empiricism. Research gamers are trying to find out if we can get some sort of validation concerning such behavior.

In this context I mention a couple of subjects which concern the interface between operational and experimental gaming. One is panic behavior, related to the general question of stability in social systems. An operational problem that many of us face is the question of how to control hijacking. What is the nature of the steps one can take in the case of aircraft hijacking? Many of our assumptions that go into trying to answer this question at an operational level involve the motivation of those who try to take over the planes and the nature of crowd behavior when a plane is taken over. These odd-ball subjects that we refer to every now and then, and which have considerable operational implications we know little about. The experimental gamers, working in highly artificial situations, are at least beginning to ask questions such as: Can you cause a panic in a simple market game? The answer to that question is Yes. In running an experimental

business game with a stock market attached to it, we were able to cause a rather spectacular panic, in the middle of the game, which I had not foreseen. This brings back the difference between experimental gaming from the point of view of theory generation and experimental gaming from the point of view of theory validation. Sometimes when you run an experimental game you find that you can cause behavior that you did not even think was part of the game you were running.

FUTUROLOGY

The last of the subjects that I want to note on briefly is futurology. Although not directly related to gaming, it is certainly allied. The question that I want to raise with all of you here is: What does the upper bureaucracy learn from gaming exercises when trying to estimate what will happen in the future and when trying to convey it to someone?

In this connection I would like to make a semantic note. In academic circles one talks about members of upper bureaucracies as "decision-makers". I suggest instead we use the phrase "responsibility-taker". I am not quite sure what a decision-maker is, but I am rather sure what a responsibility-taker is. It is someone who finds that when something goes wrong in a part of the bureaucracy he is meant to be responsible for the fact that something went wrong. This is much more congenial to my view of the way institutions work than to attach this vague word decision-maker to him.

I raise this point because a responsibility-taker finds that the only real asset he has is time. He tries to allocate this time as parsimoniously as possible. When for example a futurologist or an operations researcher comes to this responsibility-taker with a 35 page questionnaire, he will frequently not fill it in, or if he fills it in, he may fill it in casually. The questions we have to ask against this background are as follows: How does this study get used? Do responsibility-takers like people in their organizations to play games? Do they like them to do long range futures studies? And if they do, how do they use the output of these games? What are the motivations?

A former student of mine, Bill Asher, recently did a study of a great number of forecasts. One of his conclusions was that there was a great misunderstanding between the people who used forecasts and the people who prepared them. His conclusion was rather strange but not as pessimistic as one might think! The people preparing the forecasts felt that their work was not used and that they did not have the right connections with the upper level of responsibility-takers. Yet the people who sponsored and claimed to use the forecasts were much happier. They were quite willing to admit that maybe they did not talk with forecasters, but they regarded this sort of work as a vital input to what they had to do. The

gap seemed to be between the perception of the preparer of planning studies, and the responsibility-taker's perception of how he used the work. From my own experience I know that on occasions certain executives would not make decisions until the long range forecast had been presented to them. Although they scarcely read the long range forecasts, until the volume was on their desk and they had laid hands on it, they would not act. There is more than symbolic significance to this, because it meant that they knew that certain work had been done in the system and they wanted to make sure that that work had been done before they moved.

ISSUES TO BE DISCUSSED

Concluding, I want to stress, that the thrust of this conference is policy formation and implementation. This brings us to the issues to be discussed.

Among the many questions we want to discuss is the following: Do games have a value to responsibility-takers or are games primarily self-training devices for analysts? If you are going to keep a stable of analysts and experts in a major bureaucracy they have to at least educate themselves. A perfectly legitimate use of gaming might be to keep these individuals self-trained. The games may be conceptual devices for the analysts. It is not necessary that they be regarded as useless if that is all that they do. It is also not necessary that the criterion of usefulness be that you get three corporate presidents into the game you design. It well may be that there is a usefulness to a game even if it never gets to the explicit level of top management.

We furthermore have to critically explore the future of gaming as related to policy making. This is possibly the key question of this conference. Do games have a direct role in policy formulation or is their role indirect? What should be the relationship between the manufacturers of games and their sponsors? This is not a problem of gaming alone. The general question concerns the relationship between the responsibility-taker and operations research in general. To some extent IIASA was built at the time that the use of operations research probably peaked. The last five years have been devoted to some rather agonizing reappraisals of operations research in general, let alone gaming in specific. The ability to manipulate large scale computer models in operations research has coincided with some nasty questions concerning just how much operations research really has added to man's knowledge of how to run large scale bureaucracies, and how to make major plans for new programs, be they government or industrial.

It is also important to connect the role of gaming with some of the larger developmental simulations. IIASA has sponsored a series of conferences on large scale simulations. How valid are those models? Does gaming have anything to offer as a testing device of their validity?

Our last endeavor will be a discussion of long range planning and futures studies. We should at least be willing to be victims of our own medicine. We have designed a small gaming format with the hopeful purpose of finding if we can use this device to plan what should be done in this area. If we had some resources to spend in making gaming a useful tool at the level of managerial planning, what should we do with those resources?

SUMMARY OF THE DISCUSSION

Ingolf Ståhl

INTRODUCTION

The following is a brief summary of the main points of the discussion. Since the debate often took the form of one person commenting on what another person said the previous day, it has appeared meaningless to try to follow the discussion in a chronological order. Instead, the discussion points have been brought together under a few topics, regardless of whether the statements grouped together were given at the same time or not.

The selection and ordering of the view-points is completely the subjective choice of I. Stahl, but all ideas presented correspond to the very detailed notes made at the session by R. Randolph. Since the view-points are often the results of a general debate in which several people participated, it has appeared less suitable to assign names to particular view-points. Names have only been given in connection with the presentation of gaming activity in one's own institute.

OVERVIEW OF DIFFERENT GAMING ACTIVITIES

First a brief survey review was given of activities carried out at New York University (NYU) (under leadership of M. Uretsky):

1. In the masters program an expanded version of the Carnegie-Mellon game is used where real N. Y. businessmen, lawyers, judges, tax authorities, bankers, etc. play the role of externalities. This is the environment in which the corporations run by the MBA-students

operate. (In other places this role of the environment is usually played by faculty or modeled by a computer program.) This new mechanism has worked well and has replaced the traditional master's thesis. It has made MBA students start thinking like real businessmen.

2. Work has also been carried out together with the USSR Academy of Foreign Trade on a game regarding US-USSR trade negotiations. It has been structured for obtaining good connections with trade ministries to reach real decision makers and valid data. The game is based on case studies of earlier negotiations as well as general interviews with many participants.

3. NYU has also helped in the transfer of gaming technology inter alia to Hungary, Poland and Rumania.

In connection with the question of the international transfer of gaming, more information was given on gaming in Hungary (see furthermore the articles by L. Mozes in Appendix F). In this country the use, at the Karl Marx University, of the NYU game started in 1971. There, this game and its successors as well as many completely new games have been used both by managers for improving their managerial ability and by students seeking explanation of various aspects of running a firm. As regards the transfer of the game, some general changes had to be made to fit different economic and financial structures as well as some specific parameter changes, e.g., of production functions.

In Hungary games have also been used in policy analysis for testing proposed changes in economic regulations in gaming sessions using real managers and real members of directing organs (see Appendix F). The discussed policy changes have, since the playing, been implemented and one can, as a validation of the gaming sessions, afterwards estimate that the forecasts generated by the gaming sessions were roughly validated.

A brief survey was also given of gaming activities in the USSR. Over a hundred different games have been developed, applicable to different sectors of the economy. All the main points of this survey are covered by V. I. Marshev's article in Appendix E.

A specific review was also given regarding the gaming work carried out at the All Union Institute of Systems Research of the State Committee for Science and Technology (under the leadership of Danilov-Danilian). This game, focused on national planning, is also discussed in Appendix E. Here it should only be added that the size of this game - depicting a ten sector, fifteen product economy - is quite large. Another indication of size of effort is that half a dozen people will work full-time on this project; the size of the game follows from the research purpose of the game.

A brief survey was also given of gaming activities in the Netherlands, in particular of the Social Systems Research Group (SSRG) at the University of Nijmegen (J. Klabbers).

Among the gaming projects carried out or under planning at this Institute one can mention the following:

1. An energy game (in cooperation with a group from Karlsruhe in the FRG).

2. Decision-making in a research department.

3. Manpower planning in a large corporation and at a University.

4. Interactive simulation with a demographic model.

5. Dental health care.

6. Food system in a developing country.

A brief survey was given of the gaming activity at the IABG in Munich, FRG, in particular in the gaming department (K. Niemeyer). It was originally focused on military gaming, but it has more recently also carried out gaming in other areas such as environmental planning.

Some examples were given regarding military gaming. The studies concerning disarmament measures - MBFR (Mutual Balanced Force Reduction) - appeared most intersting to the workshop. The MBFR games were developed in close cooperation with military people. After several game runs for various cases (MBFR options), it was possible to create dynamic "trend models" for a great many variations of the system being modeled. (The "trend models" are closed simulation models of the same system incorporating the decision process.) These models allowed for quick response to decision-making oriented questions. This is an example of how one can incorporate the decision process into a simulation model and test various variations of the control variables.

Brief surveys were also given regarding the use of gaming in the other countries of the workshop participants (Bulgaria, Finland, France, Japan, Poland, Sweden and the UK). (As regards the Japanese experience we refer to Appendix G.) The general conclusion was that the main emphasis - outside of the military area - was on games for management education.

Among the few different experiences one noted operational games in a few corporations: In aluminium and cement (France); in the chemical industry (Poland); local government planning (Sweden); and hospital planning (the UK). Special experiences in teaching games were also noted: Games for teaching macroeconomic planning (France) and those for the teaching of top government officials (Bulgaria).

DISCUSSION OF TAXONOMY

M. Shubik's survey of the state-of-the-arts presentation contained a taxonomy of gaming which inspired some debate. Inter alia, it was pointed out that the distinction between rigid form and free form gaming might not be so clear; in particular, if one lets the players of a rigid game critique it afterwards one can obtain some of the main benefits of a free-form game. Furthermore, as regards teaching games, one should distinquish between "teaching games" and "learning games" facilitating individual subjective learning.

As regards the distinction between a research game and an operational game, it was suggested that the difference was that in the research game the person posing the question and the person designing the game was one and the same, while in the operational game these would be different people.

The taxonomy discussion clearly revealed that there was no general consensus on a taxonomy of gaming, nor on the meaning of different gaming concepts. This in turn explains why the handbook committee (see Appendix D) gave a strong priority to efforts in this area.

BENEFITS OF GAMING

During the whole workshop various statements were given as to different benefits to be derived from gaming. Some had an air of slogan. They are presented below without any specific comments and without any serious attempts at putting them in a logical order.

1. Gaming is a pre-science of clarifying concepts.

2. Gaming is a suitable brain-storming device.

3. Gaming is a heuristic device for thought experiments.

4. Gaming is the only science which uses humans not only as an end but also as a means.

5. The great benefit of gaming lies in the self-instruction of the game constructor.

6. The running of a game with experienced players is a good devise for teaching the teachers.

7. Gaming is a device for two-way learning.

8. Gaming opens the lines of communication between the players.

9. Gaming aids communication between analysts and decision-makers with regard to problem clarification.

10. Gaming can be seen as a means for communication between analysts.

11. Gaming changes the nature of feed-back loops among information preparers and information users.

12. Gaming exposes deep biases in large-scale models.

13. Gaming is the only way of pre-testing the behavioral assumptions in decision models; it puts them to the "acid test".

14. Gaming facilities the understanding of goal setting - the link between analysis and planing.

15. Gaming is an important research tool for studying the effect of the variation of policy variables.

16. Gaming is important not only in determing the "right" policies, but also for determining what the "right" players should look like.

WHY HAS OPERATIONAL GAMING NOT BEEN USED MORE EXTENSIVELY?

The many advantages of gaming - reflected in the list above - were contrasted with the conclusions that the participants at the workshop could find very few applications of operational gaming outside of the military field. This started a lively discussion as to the reasons for this discrepancy.

From workshop participants with business experience the following three reasons were given for the very limited use of operational gaming in large corporations:

1. Some top managers regard gaming as a non-serious activity and balk at the very idea of letting gaming influence their decisions.

2. Top managers think that there is nothing new that they could learn from a gaming exercise.

3. Top managers regard the games as too simple and hence too unrealistic to depict the complex reality well.

Closely connected with these objections was the feeling among participants that many gaming exercises had the weakness of inducing behavior among the participants which was too competitive. This point was particularly emphasized by the French delegates, who claimed that the confrontation implied in many game situations was unappealing to many decision-makers with a "Latin cultural" background.

The problem of gaming implementation could however, to some extent, also be explained by factors well-known from studies on the implementation of other Operations Research or Systems Analysis methods. In particular there is the problem of the outside consultant, who does not know the actual problem or decision-making structure of the studied corporation or organization. It was noted that the sponsorship of gaming models was generally that of the model constructor desiring to sell his game. Instances of top civilian managers requesting gaming appeared very rare.

This problem of gaming in the civilian sector was considered by many to be connected with the fact that operational gaming is a very new and unknown idea, and hence with virtually no 'in-house' experts: There are few people working within corporations who have experience of gaming construction. This contrasts strongly with the military where gaming has a century-long tradition in several countries; thus there are many 'in-house' experts available.

The discussion then focused on the reasons for gaming being successful in the military field as opposed to the civilian. One questioned whether the answer lay only on the "tradition" side. Another important difference between the military and the civilian was the time factor. In peace-time, top level military people have considerable time for long term planning activities such as gaming, while people on the civilian side would constantly be "at war", having to tend first of all to short term "muddling through".

In this connection the importance of getting the "correct" players was stressed. A very busy top-level executive could not be easily replaced in an operational game by a very junior employee (who has the time to play) because the latter has dissimilar experience and perspectives.

The duration factor was considered important in another respect. Much top level military gaming is focused on long-term, e.g., five year planning, where gaming is used partly as a discussion devise, when different branches of the armed forces bargain over their share of a fairly fixed cake. The outcome of this bargaining would in some countries bind the relative size of these branches to within fairly narrow limits for the next five years. Within private corporations long term planning could seldom be binding to this extent. The existence of a market on which the corporation could expand (or contract) lessens the importance of this type of intra-organizational bargaining and hence also the importance of gaming as a bargaining device for allocation within bureaucracies.

WHAT KIND OF GAMING IS IMPLEMENTABLE?

Against the background of these negative factors, the discussion tried to focus on what kind of operational gaming would most likely be successful in terms of being implemented for the solution of actual problems.

First of all it was stressed that gaming should not be seen as the only Systems Analysis tool in the analysis of a problem. Rather its usefulness would be increased if it was presented as one of several tools in the analysis of a concrete problem. Gaming should be seen as an important complement to these other tools, be it optimization, simulation, econometrics, Delphi, etc. Gaming could bring out critical aspects that could not be reached by these other methods.

Closely connected with this idea was that of the "soft selling" of gaming. Not only would it be wise to present gaming as one of several tools in the S.A. tool box, but it would also be wise to "warm the managers up" to gaming by, for example, presenting some very simple games before more complicated ones.

The discussion then turned to the kind of problems in the civilian sector which would be most suitable for gaming. Several participants believed that an emphasis on tactical rather than strategical problems and middle management rather than top management problems would be more fruitful in terms of the chances of implementation. It was suggested that the likelihood of success would increase in games where,

a) a well understood process was modeled,
b) the players had a clear objective, and
c) real players were playing their own roles.

An example of successful implementation was the gaming of queuing behavior in a traffic system, which lead to new improved queuing equations in a simulation model.

There was some disagreement among the participants as to whether free or rigid form gaming would be most successful. The free form gaming - focused on one shot playing - had the advantage of giving insights and opening the communication channels, while rigid form gaming made possible replicability and hence also the investigation, by iterative playing, of the effect of changing certain decision parameters. There seemed, however, to be more agreement on the desirability of having some stochastic processes involved in the game, emphasizing the lack of information about the environment in the real world.

GAMING, FUTURE STUDIES AND LONG TERM PLANNING

A considerable part of the discussion was focused on the relationship between gaming, future studies and long term planning.

There was first a presentation of the research carried out at IIASA in the field of Cross-Impact gaming. (Presented inter alia in Helmer, 1978. Cross-Impact Gaming applied to Global Resources IIASA-RM-78-004.) A brief review was also given of earlier work on global forecasting gaming, leading up to the GEM game produced at IIASA. (Helmer and Blencke, 1979)

Gaming appeared to be useful as regards two forecasting objectives. In the first instance gaming could indicate what choices would, for political, personal and psychological reasons be possible; in the second instance it would be one of several modeling efforts to analyse the future effects of various actions. It was seen here as an important complement to other multi-disciplinary methods like Delphi. Gaming could, by improving interdisciplinary communication, get a better and richer set of "informed judgements" and hence improve the forecasts.

In the discussions it was further emphasized that one should not necessarily aim at very complicated and detailed LRP (Long Range Planning), but rather focus on the most important structural aspects, with the ensuing similar recommendations for simple gaming in regard to LRP. It is natural that the longer the time span of the planning, the less one would work with details and the more with aggregated data.

Another aspect in which gaming could shed light on forecasts was the following: There might in some cases be a difference between the forecasts one believes in and the forecasts that one discloses. The very fact that a well known government official or business leader discloses a forecast will cause other decision makers to react in a certain way, e.g., disclosing a forecast of high inflation might in itself increase inflation. Gaming offers one way of studying this discrepancy between "true" and disclosed forecasts.

IN WHAT KIND OF GAMING SHOULD IIASA BE INVOLVED?

As regards the fundamental question of whether IIASA should be involved in gaming research or not there appeared to be a unanimous opinion in the affirmative. The motivations were of two kinds.

1. Gaming is a potentially promising Systems Analysis tool for reasons covered above. Gaming would be an important complement to other SA methods in many of IIASA's programs and areas.

2. IIASA has a great comparative advantage in this research, particularly in getting real decision-makers from different countries to participate in gaming activities. Thus IIASA has the advantage of being in a position to study cross-cultural differences in decision making. IIASA activity in the gaming field could, furthermore, increase east-west contacts - something which appeared to be of great importance - particularly as the very substantial gaming work within the CMEA countries manifested e.g., by the annual gaming symposia there, seemed little known in the west.

Hence, with the background of a consensus on the desirability of an IIASA involvement in research on gaming, the discussion focused on what concrete form this involvement should take. This discussion was carried out in four different phases:

1. The workshop participants received a list of 31 different gaming research suggestions (partly supplied prior to the workshop by the participants themselves). The participants were divided into small groups to discuss these suggestions and after this rank them according to their desirability as regards IIASA future research as well as an estimate of the required input in terms of man years. These suggestions as well as the results of this exercise are given below.

   Here it should only be mentioned that the most preferred suggestions were:

   -- Experimentation with free form gaming
   -- Handbook on operational gaming
   -- Gaming to facilitate the implementation of international projects
   -- National economic planning
   -- Global economic modeling

2. The workshop split up into two smaller groups, one working on the whole IIASA program involving gaming. This workgroup produced a report, presented in Appendix C. As seen here, it recommends that an IIASA involvement should be slow and relatively risk free. As a possible portfolio mix it suggests a handbook, a gaming effort based on an existing IIASA area, and a well-bounded game development on a problem of international significance.

3. The other workshop participants formed a group to discuss the possible contents of an IIASA handbook on gaming. The suggestion of this group is presented in Appendix D.

4. After the oral presentations of the outcome of the gaming exercise and the two reports of the working groups, was the final discussion which indicated fairly high agreement on these two reports and the general fairly cautious approach advocated. This in turn indicated that the more risky methodological research, e.g., on free form gaming, preferred in the exercise, would have to come later in time.

REFERENCES

Helmer, O. 1978. Cross-Impact Gaming Applied to Global Resources, Res. Mem. RM-78-4, International Institute for Applied Systems Analysis, Laxenburg, Austria.

Helmer, O., and L. Blencke. 1979. GEM: An Interactive Simulation Model of the Global Economy. Res. Rep. RR-79-4, International Institute for Applied Systems Analysis, Laxenburg, Austria.

REPORT ON THE WORKSHOP EXERCISE

Olaf Helmer

One portion of the workshop on the utility of gaming as an aid in policy formulation and implementation consisted in an exercise intended to introduce a change of pace in the proceedings and to impose something of a systems-analytical approach on this portion of the workshop. The exercise was divided into three parts, having to do, respectively, with invention, evaluation, and resource allocation.

Part I, which in fact was carried out prior to the workshop proper, called for the nomination of proposals for gaming research that would serve the purpose of advancing the kind of operational gaming which might be useful in policy formulation and policy implementation. The result consisted in a list of 31 such research proposals, listed below; about half of these were generated by IIASA staff members, the rest by non-IIASA participants:

1. MANAGEMENT GAMING SURVEY

An examination of generic gaming approaches to management problems generally, including, in particular, the use of gaming as a training and communication device. There are many forms of gaming models in existence, from informal personal-interaction games to fully computerized simulations. The proposed study would be directed at categorizing such models and systematically analuzing the relative utility of their various features to the promotion of better organizational management.

2. MODELING AND GAMING

Increasingly the value of models in policy development is seen to lie in the way that they inform policy-makers of the likely behavior of the system for which they are making a policy. However sophisticated the model, there is a danger that the results can be used very crudely. A study of the possible gaming uses of the models developed by IIASA's Food and Energy Programs would help both these Programs and also enhance development of the subject itself.

3. INTERNATIONAL RELATIONS

An examination of the potential utility of gaming methods for the study of international relations, with special emphasis on scientific, technological, and cultural cooperation, and on the reduction of international tension. An international research environment (such as is provided by IIASA) might be conducive to studying problems of this kind, and a gaming approach might be helpful in that it encourages the participants to view the situation through the eyes of persons with national backgrounds different from their own.

4. ANTI-POLLUTION GAMING

Application of cross-impact gaming to the study of effective anti-pollution measures. The fight against pollution involves examination of many interacting factors, such as technological developments, economic considerations, regulatory measures, and the multidimensional effects upon people generally. A cross-impact game may represent a suitable first vehicle for studying these complex interactions, since it permits the introduction of stochastic events (such as technological breakthroughs or environmental catastrophes) and of strategic interventions (such as R+D investments, regulatory stipulations, pollution-depressing measures at the sources, and international agreements).

5. HANDBOOK ON OPERATIONAL GAMING

There is a lot of experience and wisdom available on gaming matters, but no very good reference for the beginner to turn to. He asks such questions as to the degree to which one should match reality, how much (if any) replication is appropriate, when students can be used, and when experts. If a handbook on operational gaming were to be prepared, the chapters could probably be written by invited experts, but careful organization would be needed first.

6. NATIONAL ECONOMIC PLANNING

Development of a gaming model dealing with an industrialized nation's economic development problems. Players in such a game might represent the government (possibly divided into Legislative and Executive), labor, the managers of various industrial sectors, the banking system, etc. The number of economic sectors represented in the model should be quite small and probably not exceed ten. The purpose should be to provide intuitive insights into the interactions between economic factors and non-economic aspects, such as technological, environmental, or political, and thereby lead to improved economic forecasting and planning models. Particular emphasis hsould be on a search for measures to reduce both unemployemnt and inflation simultaneously.

7. GAMING AS AN ORGANIZATIONAL DESIGN TOOL

A systematic study of the utility of operational gaming as a tool in the design of organizational structures. A particular case in point would be an application to the organizational design of a legislative body. Another example might be the design of a social-welfare system.

8. THE VALIDITY OF GAMING

It is easily - perhaps too easily - accepted that replication is difficult in gaming, but no effective analysis has been undertaken to see how the results can be acceptably validated, - by use of modern statistical methods, simultaneous simulations, paired comparisions, etc. A study of the methods used so far and discussions with specialists could prove more fruitful in putting the subject on a more rigorous basis.

9. DEVELOPING COUNTRIES

Construction of a gaming model concerning development problems of a developing country, with special emphasis on its agricultural economy. The model, possibly using a cross-impact approach, should be multidisciplinary rather than purely econometric, allowing for the interaction of social, economic, technological, and environmental developments.

10. GAMING AS A SCENARIO TEST

Explore the effort-effectiveness of gaming versus other types of scenario tests or reviews (including less formalized "polling", "role playing", or "trouble shooting") by applying the tests to IIASA's Energy and Food scenarios, with emphasis on questions of their effectiveness, completeness, acceptability, and implementation.

11. IMPACTS OF AWARENESS LEVELS ON STRATEGY PREFERENCES

Explore the effort-effectiveness of gaming contrasted with other types of scenario tests or reviews (including less formalized "polling"). Establish by repeat-testing how a non-expert's preferences among alternative energy strategies is affected by successive additional levels of education about what we think we know (or don't know) about society's future resources and demands. The economic impact of different energy future resources and demands. The economic impact of different energy supply levels and environmental effects and risks should be included.

12. MEASURES FOR EVALUATING PERFORMANCE

In cross-impact type gaming, the results obtained should be evaluated multidimensionally. At the same time, the researchers have to deal with a kind of optimization problem in which each subgroup is trying to optimize its own objective function using a different value measure. Very frequently any results obtained from gaming would be so different and conflicting with each other that researchers might not arrive at unique or definite conclusions. Some theoretical study might be helpful toward developing an appropriate measure for evaluating such results.

13. PUBLIC PARTICIPATION IN PLANNING

In many situations, e.g., urban planning, the public ideally is a part of the decision making-system. If the public is ignored, it operates as a constraint on the progress of implementation, or against the best functioning of the resulting new system.

Questionnaires are often used to sample public opinions, so as to be able to take this into account; equally often these questionnaires are ill-understood, and answers, in any case, relate to unexplicit personal constructs of what the present system is and what the new one might be. Games should be developed which the public can play (as planners) so as to understand what is feasible at what cost, what trade-offs exist, etc. Their responses, after the game. could replace questionnaires or be used as an aid to providing efficient and meaningful questionnaires for wider sampling.

14. DATA AND INFORMATION

What data are translated into information for the purposes of an individual's decision in a complex situation is generally unknown. Research games are needed to identify the relationships between data, information, and decision (under various environmental states, e.g., stress). It should be possible to simplify and improve management information systems, if relevant relationships can be determined. It should also be possible to achieve a better understanding of the checks that need to be made on decision processes under crisis conditions.

15. CARTELS IN INTERNATIONAL COMMODITY MARKETS

The use of gaming models for the study of the conditions for the formation, operation, and viability of producer cartels in international commodity markets (for instance, for coffee, copper, oil, etc.). A similar investigation could be undertaken with respect to the European agricultural policy concerning dairy farming, wine growing, etc.

16. GOVERNMENT PLANNING OF INDUSTRY BRANCHES

In a game involving a handful of firms producing similar products (e.g., steel) but at different costs, one could study the effect of various government intervention instruments, such as forecasts, subsidies (of wages or interest), production coordination, etc., on decisions regarding output, price, and investment. The research should involve not only the construction of the game but also the running of it, using executives from the branch of industry under study.

17. SEALED-BID AUCTIONS

The use of gaming models for the analysis of the benefits of sealed-bid auctions to governments, participating companies, and society in general when calling for tenders for contracts, bids for exploration leases, etc., under different rules and varying degrees of incomplete information.

18. GROUP DECISION MAKING

It is well known that optimization models cannot always be used to allocate resources between several competitors (nations, companies, etc.) because the optimum may be very unfair.

To achieve a better understanding and more rational resource allocations in difficult group decision-making situations, we propose that a game-theoretical framework and a gaming model be developed with which to test the possible outcome of such decisions. This could help to show the nature of possible conflicts of interest to the partners or competitors and also to measure the possible benefits from a cooperative or optimal solution. It might be possible to include game-theoretic solution methods to determine side payments if needed.

19. INTERACTIVE STUDY OF ORGANIZATIONS

An exploration of the utility of a gaming approach to the study of organizations. Despite the success of numerous sporadic efforts in the study of organizations, there is at present no unified theory of organizations. This would require a clearcut

conceptual apparatus and a methodology for prediction. To achieve the former within the foreseeable future it might be wise to tie into the existing conceptual framework of game theory; the latter may require taking a new look at the psychological problems involved and introducing something like an operational-gaming approach to them.

20. ARMS CONTROL

The development of a suitable gaming approach to the study of arms control. The problem area of arms control may be viewed as a conceptually high complex non-zero-sum game situation, of a kind where the mathematical theory of games may not be capable of contributing a satisfactory "solution". Operational gaming, on the other hand, by utilizing the intuitive expertise of players, may throw some light on the impediments to effective arms limitations and thereby open the way to a constructive international approach in this area.

21. GLOBAL ECONOMIC MODELING

Construction of a six- to ten-player game dealing with global economic interactions. Each player in this game should be responsible for managing the economy of one of several (six to ten) world regions (possibly those of the Mesarovic/Pestel model on which the "Mankind at the Turning Point" report is based). The players' moves would involve resource allocation decisions (between economic-sector inputs, capital investment, investment in R+D, and supplies to consumers and to government) as well as decisions on interactions with the other participants (on commodity trades, long-term trade agreements, loans, investments, and technology transfer).

22. GAMING AS A MEANS OF BEHAVIOR FORECASTING

The development and study of simulation games designed to forecast the behavior of individuals or of firms (or other organizations) in response to changes in the operating environment.

23. GAMES TO INSTRUCT MANAGERS

Many business games have been designed for the purpose of instructing managers or training would-be managers. A survey of such games and their success should be made, and possibly new games of this kind should be designed and experimented with.

24. GAMING AS A TOOL IN DEVELOPMENT COOPERATION

Construction of a game concerning development cooperation between a developing and a developed country. The game should convey national values and priorities of both countries as a condition for possible cooperation. These values and political affairs of both countries may hamper or make aid or acceptance of aid impossible. A game might help in understanding each position and result in mutual understanding and subsequently in laying down the conditions for cooperation.

25. INTERNATIONAL ORGANIZATIONS

Development of a feasible and realistic plan and program for the systematic development and implementation of gaming methods or similar instruments for use in international organizations. The aim would be the application of such methods within these organizations and the nations involved in them as a basis for the rationalization of the international discussions, the evaluation of proposed problem solutions, the mutual learning and understanding of international relations and problems (such as issues relating to pollution, research, development, social aspects, resources, food, population, military forces, etc.), and the establishment of a common data base and its application. It seems to be important that the very early integration of decision-makers (those responsible for decisions) into the implementation of such a program and into the development and usage of the games and other simulation instruments developed in the course of such a program.

26. INTERNATIONAL GAMING EFFORT TO AUGMENT IIASA RESEARCH ACTIVITIES

Develop an international gaming network that would permit IIASA-developed models to be used as the core of games that would be played by participants around the world. This network would use: existing communications and computer facilities, IIASA-developed models, coordinating organizations in NMOs, and policy maker/expert players in the NMOs. If developed, this network would permit the following kinds of benefits to be achieved: reflecting national perspectives in research, incorporating expertise that cannot be physically located at IIASA, improve linkage with applied interests, and partial validation of models.

27. GAMING TO FACILITATE THE IMPLEMENTATION OF INTERNATIONAL PROJECTS

Develop gaming methodology and software to investigate the problems associated with the implementation of international projects, such as construction, production, etc. This gaming activity can include the following components: methodology and (possibly) software development; construction of a game to reflect a technology transfer and implementation situation; experimentation with the game using scientists, management specialists, and managers; problem identification; and development of a program to train people to avoid these problems. The output might include: methodology and handbook, software for game design; experimental results, problem identification, and training programs.

28. GAMING AS A SIMULATION AND LARGE-SCALE SYSTEM MODELLING CONTROL

This is a proposal to utilize gaming as a heuristic control device and sensitivity analysis tool. The basic idea is to utilize small games to explore, challenge, and hopefully improve the basic assumptions underlying basic systems studies, be they in energy; population; food; overall representations of the economy; and the set of models variously called global simulations. The games should first be played by systems designers, then with outside experts, and possibly some of the administrators with direct experience.

29. EXPERIMENTATION WITH FREE-FORM GAMING

Develop methodological framework for free-form gaming as a tool for self-education of the designers which may include gaming experts but also technical experts and managers functioning as a team.

Explore the advantages of the gaming exercise such as improved communication among the parties, exploitation of attitudes, relevation of strategic behavior.

The project may concentrate on some specific areas such as allocation of resources, trade negotiations, industrial procurement contracting.

In this conjunction of free-form gaming and objective area, the idea would be to identify the kinds of theoretic expertise which may be used and how it should be successfully implemented.

30. GAMING AS AN EXPERIMENTAL TOOL FOR TRADING OFF BETWEEN LONG-,MEDIUM-, AND SHORT-TERM ISSUES IN PLANNING

The relationship between long-term strategies or even longer-term "alternative future" studies on the one hand and the short-term decision formation processes on the other is a little explored area of operations research. Gaming might provide an interactive process for improving the feed-in of long-term development need into present-day activities.

IIASA's issue-oriented research, e.g., on development strategies for the (global) energy system or for the (global) food and agriculture system, addresses problems in which the coupling between long-term societal needs and necessary action for the more immediate future requires more attention than usually is given. One main reason for this is that OR concentrates largely on improving the process of decision formulation and that future studies often concentrate largely on more meta-type assessments of long-term development or on final constellations of the societal system at the time horizon of the study.

Gaming could bring these two parties into a useful investigation of the long-term consequences of certain behavioral modes of today and - vice versa - of the impact that long-term needs ought to have for today's actions.

31. GAMING FOR PRELIMINARY ASSESSMENT OF POLICY ALTERNATIVES

Sometimes very powerful econometric models are converted into simulation models by pulling out endogenized policy behavior and allowing exogeneous input of a set of policy instruments. Whenever these models are highly disaggregate and complex, the heuristic problem of combinatorial complexity arises. Here gaming, perhaps supported by more aggregate simulation models, could provide a "fast filter". An interactive process is conceivable in which simulation gaming identifies attractive alternatives and econometrics provides the "fine-tuning".

Part II consisted in an evaluation of these proposals. The conferees, for this purpose, were divided up into 5 panels, each of which was asked to examine each of the proposals, discuss it within the panel if desired, and arrive at two group assessments:

A: the importance of the contribution to the purpose stated which a successful execution of the proposal would represent, using a scale from 0 to 4, where

0 = of no importance
1 = of slight importance
2 = of moderate importance
3 = of considerable importance
4 = of outstanding importance

B: The number of research man-years required to do reasonable justice to the proposed research

As it turned out, one of the panels decided not to estimate B numerically but merely to make an assessment whether the required number of man-years was low (L), medium (M), or high (H). To make the responses of all panels comparable, the numerical answers to B were converted into L, M and H responses by roughly translating the lowest third of the numbers into L, the next lowest third into M, and the highest into H. The results, in terms of the median (central column) and range of responses, are tabulated below.

Proposal No.	Importance			Research man-years		
1	1	1.5	3	L	L	L
2	1	3	3.5	M	M	M/H
3	2	3	4	L	H	H
4	1	2	3	L	M	M
5	2	3	4	L	M	M
6	0	2	3.5	L	H	H
7	2	3	3.5	M	M/H	H
8	1	2	3	L	M	M
9	0	3	4	M	H	H
10	0	2	4	M	M/H	H
11	0	3	3.8	L	M	M
12	0	1	3	L	M	M/H
13	0	3	4	L	M	H
14	2	3	3.2	L	M	H
15	0	2	3	L	H	H
16	2	3	3	M	H	H
17	0	0	3	L	L/M	M
18	0	2	3.8	M	M	M
19	0	2	2.2	M	M	M
20	0	2	3.6	M	H	H
21	0	3	4	L	M/H	H
22	0	2	3	L	H	H
23	0	1.5	4	L	L	M/H
24	0	2.1	4	L	M	H
25	0	3	4	H	H	H
26	0	1.8	4	M	M/H	H
27	2	3	4	L	H	H
28	0	2	4	M	H	H
29	2	2.5	4	M	M/H	H
30	1	1.5	3	M	M/H	H
31	0	3	4	L	M	M/H

As can be seen the spread of opinions in many instances was quite high, so that nothing approaching a consensus was achieved. (A feedback and iteration process, a la Delphi, might have produced some convergence of views, but time constraints prevented any attempt in this direction.) Nevertheless, the conferees, by considering and discussing the 31 proposals, familiarized themselves sufficiently with them to be better prepared for the next phase of the exercise.

Part III of the exercise required each participant:

1. To check those 5 research proposals he considered relatively most important (giving no consideration to the man-power requirements for carrying out the proposed research).

2. To distribute a total of 100 points over the 31 proposals (plus a 32nd one simply labelled "other"), reflecting his preference as to how a research effort should be allocated; the instructions to the respondents explained that the 100 points might be thought of as representing

100 man-years (20 man-years over a period of 5 years) together devoted to the subject at hand by various research institutions such as IIASA.

The answers to question 1 displayed a great deal more of a consensus than had appeared in the outcome of Part II. By counting how many of the respondents included an item among the 5 most important ones, the following priority ranking resulted:

Priority 1: Item 29
Priority 2: Items 5 and 27
Priority 3: Items 6 and 21
Priority 4: Items 3, 11, and 13

As for the responses to question 2, they were combined into a single "master" allocation, using the procedure outlined in WP-78-25 ("Voter Satisfaction Maximization in Problems of Resource Allocation", by Olaf Helmer), as follows:

Proposal No.	Points allocated	Proposal No.	Points allocated
2	5	14	5
3	10	15	3
5	10	17	1
6	10	18	3
8	1	21	8
9	6	27	10
10	1	28	6
11	5	29	10
13	6		100

(This master allocation satisfied 81% of the individual allocations in the sense that, in 81% of the 736 cases [= 23 respondents x 32 items], the amount allocated was at least equal to that advocated by the individual).

CLOSING REMARKS

Martin Shubik

Given the intensity of the discussion of the last few days, it is somewhat difficult to summarize everything that is being said in a few words.

The actual title of the conference was, "Gaming as an Aid in Policy Formulation and Implementation". I think that we, in fact, did look at these questions. Our conclusions were roughly as follows:

There has really been very little non-military high level direct policy gaming. We have had remarks on some of the problems of the interface between those who build models, those who operate them, those who sponsor, and those who are in positions of what I call "responsibility taking".

We also discussed and observed that there has been some high operational policy formulation implementation uses of gaming in the military. However, it was observed that when you looked a little more closely, some of the important and valuable military applications were essentially in budget allocation and that one could possibly strike out the word military and replace it by the word bureaucratic. There was an important and characterizing difference between bureaucracies and market oriented corporations in the time horizon of the bureaucracy involved, and in the demand-supply relationship facing the corporations. In a corporation, if one could not slice the pie, one immediately started to talk about the bigger pie, whether real or false. When, on the other hand, in a bureaucracy your budget is x, then it becomes imperative that the individuals involved share a fixed amount in some particular way or the other.

Concerning the actual state of the art, we identified at different periods of the meeting, valid applications of gaming at the tactical and OR level. At those levels, the discussion had none of the future perfect aspects to it, but we in fact talked about work that had been done, and even done with certain amounts of success. Rolfe Tomlinson, himself, discussed his own experiences in this Area, and others of us noted specific applications.

As regards the next step up the program, above the tactical level, we appeared to have reached considerable consensus on gaming as a modeling and sensitivity analysis device that could be used in the control of large scale simulations and in the examination of systems programs. This ties in with the idea that gaming is a useful heuristic device. The observation was that there seems to be considerable potential and value in direct application of gaming in testing concepts in and feasibility of large scale projects. As a matter of fact, this has come up time and time again in this conference.

The general feeling seemed to be that once you have a model with many behavioral equations and charts and flow diagrams, it is nice to have some form of device which can ask a few relevant questions before somebody looks at his watch and says, "We have not enough time to think of that, we have thirty more charts to get through in the next ten minutes".

Another theme which I personally feel was of considerable significance, and which relates to the general question of policy formulation and implementation, was the following: It was recognized that a very important use of gaming, especially if it involved managers was that the analysts could learn from the managers and that communication with those who are responsible for what happens could be established. Gaming as an on-going part of a decision process in a large organization is intimately related to the neural network of that organization and to having the planners, the gamers, and the managers communicate in a natural and high trust mode. Possibly one of the reasons why gaming had been effective in some military establishments was historical--the level of trust between the different individuals existed and was long-term. It is important to consider how such levels of trust and communication can be established.

If games were run at IIASA it would be extremely important to have various managers from the member countries come into a context in which two-way communication and trust can be established. This is a very delicate process and one can easily do the very reverse by trying to structure too much formalism and too little communication. Furthermore, there has been an observation by a fair number of participants of a high need for the development of a methodology. Now this is sometimes a pro forma plea for virtue, but when the problems are identified, we may wish to take this plea somewhat seriously.

As regards methodology, there were remarks on the potential of the free-form game, and an interest in the development of a methodology in this area. Historically, in the United States, a strange thing happened in the development of the free-form game. It developed very fast at one period and then virtually disappeared. In the last year or two, precisely coinciding with the reaction to operations research, there is a new interest in this area, and I predict that this interest will grow.

There were also several comments in the methodology area on the realization of what might be called the need for the eventual development of a theory of gaming. There was less consensus among us as to how much of straight methodology development should and could be done here. I think, frankly, that I was encouraged to see that the importance of this area was clearly identified. People were even able to make specific comments. Yet there was enough sense of the realities of resource allocation as to question exactly what was the best mode of procedure. I think all of us, in the course of the next few years, are going to have to look at that question very carefully. I here want to refer to Mr. Bowen's work on the development of methodology and the fact that he himself is cooperating with universities at that level.

When we turned to the question of whether there should be research on gaming at IIASA, I think that there was a clear, constructive, and cautious answer: Yes, something is worth doing. I phrase it that way because I want to stress to you that some of us who are old in ways of working conferences, have too often been at meetings which take on the aspect of a primitive religious revival meeting, where you have asked all believers to come to a meeting to discuss whether the believers have a place in this world. Under such circumstances, you usually get a fairly clear consensus. Fortunately, we went out of our way not to load this meeting purely with old believers and I think we obtained a cautious and sane scientific view as to where we stand.

Can we specify precisely what the program of IIASA should be? I think the answer is not yet; but I think there was a considerable clarification and without any question, a great narrowing down of the possibilities. It will be part of the problem of IIASA to consider the suggestions from the two working groups and to communicate and interact with you at a later date.

An optimistic and important aspect of this conference was the question of personnel. It is lovely to have all sorts of ideas about what we are going to do in the perfect future, but a tiny element that is involved is, "does one have talented, committed, personnel who are going to give the appropriate time to the project!" Speaking from my own experiences in research management, I can assure you that that which spells the difference between success and failure in even the most perfect of planned research work, is whether you have at least one motivated, dedicated, and intelligent individual working on the problem. It is not that easy to locate them, especially from afar, and especially in an international organization.

The last comment ties in with the simple question: "Is there a serious interest in the subject and does the interest seem to be based on serious motivation?" I think that the answer has been plainly, yes.

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APPENDIX B: AGENDA

I I A S A W O R K S H O P

On Gaming as an Aid in Policy Formulation and Implementation

August 29 to September 1, 1978

Place: Seminar Room, IIASA, Laxenburg

AGENDA

August 29
9:45-12:15

1. OPENING SESSION
(Chairman: Tomlinson)

Introduction

State of the Art (Shubik)

General discussion

2. PLANNING & MANAGEMENT GAMES

This subject will be covered in two sessions dealing with two distinct levels of gaming. Both have involved those with responsibility for decision and/or those who were close advisors in the decision process. These relatively low and high levels of complexity of the decision environment span the range of games played: there is no intention of inhibiting discussion of intermediate levels. The aim is to set the scene for useful critical discussion of future prospects for gaming as an acceptable aid to policy formulation, and for a participative exploration of possible future programs for the development and use of gaming methodology.

14:00 -
17:00

2.1 GAMES AT SUB-NATIONAL LEVELS OF DECISION RESPONSIBILITY
(Chairman: Bowen)

Brief description of specific games of this type, identifying what was done, why, and with what results.

Open discussion; questions such as:

- What organizations use these games?
- In what senses, including sociological and environmental understanding, have the consequences (explicit or implicit) of the gaming been of value, and to whom?

(Aug.29 14:00-17:00 cont'd)

- Are there aspects of such games which, in retrospect, should be considered undesirable or commendable?
- In what sorts of organizational (cultural) environments has gaming flourished or failed
  - in its value to analysts?
  - in its value to those responsible for decisions?
- Are there major lessons to be learned for the future?

August 30
9:00 - 12:00

2.2 GAMES AT NATIONAL OR INTERNATIONAL LEVELS OF DECISION RESPONSIBILITY
(Chairman: de Janosi)

Brief discussions of specific games and and other simulations at these levels identifying certain aspects of what was done, why, and with what results. (Examples might include COW; a modified form of Limits to Growth; Brazil; Guetzkow's games; etc.) These games tend to be on a large scale, and can only be very generally described. They represent situations in which decisionmaking is often diffuse and highly interactive.

Open discussion; questions such as:

- Those listed in 2.1 above
- What is the relationship between games and simulations which do not involve human players? (It is assumed that some use of high-speed digital computer simulation may aid game-playing.)
- Is there a point in the spectrum of the level of decision responsibility (assumed to be roughly commensurate with complexity of decision environment) at which a change in the kind of games played should take place? And why should this occur?
- What merits and difficulties are there in free-form gaming, i.e.,

gaming in which the rules are created by interaction between players and those who control the game?

- o What, in general, are the limitations of gaming? E.g., what important 'unrealities' arise when attempting to model more complex decision situations?

(Aug.30)
14:00 -
17:00

3. A CRITICAL EXPLORATION OF THE FUTURE PROSPECTS FOR GAMING IN RELATION TO POLICY-MAKING
(Chairman: Niemeyer)

This session is concerned with the potential of gaming (and its acceptability) as a tool for self-education and mutual education for sponsors, analysts, planners, and those responsible for decisions.

Reflections on, and reactions to, gaming by policymakers

Open discussion; questions such as:

- o Do games have a direct role to play as an aid to policy formulation?
- o Should the main aim of games be the self-education of analysts; the briefing of policy-makers or sponsors; the provision of a basis for mutual communication and understanding between these different groups; or what?
- o What seems to be the policy-makers' view of the role of operations-research advice in general, and of games in particular?
- o Are there cultural or conceptual reasons why gaming of major social policy problems has not been widely seen as a 'natural" process, as it appears to have been for military strategic and tactical inquiry for many centuries?

August 31
9:00 -
12:00

4. A SEARCH FOR FUTURE DIRECTIONS FOR THE DEVELOPMENT OF GAMING
(Chairman: Shubik)

4.1 A Research Planning Exercise, Part I
(Helmer)

A participatory inquiry into how resources available for gaming studies/research might be allocated

4.2 Survey of gaming activities

An opportunity for NMO representatives to give brief reports on the main thrust of gaming activities in their countries

Free, unstructured discussion, to be followed by a free afternoon (during which even freer discussion might be generated)

Sept. 1
9:00 -
12:00

4.3 A Research Planning Exercise, Part II

This will be preceded by a report on the findings of Part I

4.4 The Relationship of Long-Range Planning and Futures Studies to Gaming
(Chairman: Pestel)

Can the gaming format provide a proper and desirable framework for long-range planning of the future?

If gaming is not fundamental to futures studies, has it a role to play, and what is this role?

Is there time (and inclination) for game-playing in a long-range planner's schedule?

Are there possibilities for useful gaming support to IIASA's ongoing simulation studies of, for example, food and energy?

(Sept.1)
14:00 -
17:00

5. CLOSING SESSION
(Chairman: Tomlinson)

Conference summary

Final questions and discussion, including:

- Is there a role for gaming in support of IIASA's research planning?
- Should IIASA be carrying out gaming research, or be encouraging it elsewhere?
- How can exchange of information in this field be improved?

APPENDIX C: A PROGRAM FOR IIASA INVOLVEMENT WITH GAMING

I IIASA should become involved in gaming activities.

A. Reasons for involvement

-- Tool is useful
-- Has an international orientation and it can benefit from international skills and perspectives.

B. No disagreement in group regarding need to move ahead.

II Initial approach of group--not directly productive.

A. Possible activities were listed

-- Handbook
-- Develop or distribute software to aid game construction
-- Prepare and offer training programs on gaming
-- Maintain a gaming library and dissemination service
-- Develop games related to IIASA programs
-- Conduct methodology and evaluation research

B. Possible acceptance screening criteria were listed:

-- Minimum risk
-- Benefit applied research
-- Address problems of managers
-- Pay-off to people involved
-- Universal and/or global
-- Application has long-term (continuing) importance
-- Relative advantage to other tools

-- Benefits from an international effort
-- Benefit from other IIASA activities
-- Problems are accepted as being ill-structured
-- Relatively short time period to realize results
-- High contribution to the advancement of systems analysis
-- Help communication and understanding
-- Help interdisciplinary activity

III Agreed upon recommendations (not in order of priority)

A. Initiate involvement in gaming activities

B. Initial involvement should be slow and relatively (not entirely) risk free and related to IIASA matrix concept

-- Small number of people
-- Small number of projects
-- Limited, but multi-year, time commitment

C. Initial portfolio of projects should balance short- and long run objectives. Possible portfolio mix

1. Preparation of Handbook

-- Makes an immediate contribution
  - catalogue state of the art
  - provides guidance
  - identifies problem areas
  - identifies sources of information
-- Sets up categories for files and research
-- Relatively short time period to payoff
-- Relatively risk free
-- Relatively small manpower effort in IIASA

2. Initiate a gaming effort based on an existing IIASA area, e.g., energy or food

-- Permits gaming to assist the IIASA project
-- Relatively small incremental effort
-- High visibility
-- Risk is larger than (1) above, but still relatively small
-- Helps to address policy implications of IIASA objectives, hence it is applied
-- Provides a limited opportunity to address methodological research related to gaming
-- Provides an ability to identify thinking and information needs of decision-makers.

3. Initiate a well-bounded, limited game development activity on a problem of international significance, e.g., project implementation and/or aid to developing nations

-- Ill-structured--gaming methodology can evolve from problem
-- Benefits from international orientation and base
-- Riskier

D. A basis should be provided for some gaming activities to use an IIASA base, even though work is primarily located elsewhere

1. International
2. Neutral politically
3. Central location
4. Permits wider project involvement

E. Recognition should be given to the fact that a gaming effort can involve developing games for

-- IIASA internal use
-- IIASA and NMO use
-- NMOs with IIASA acting as a combining or disseminating agent

Note: Altnough we would have liked to have recommended a study on methodology as a major item in the portfolio, we believe that it is more practical, at this stage, to consider such research as growing from the items above so that the option is open at any time to extend the portfolio. The handbook proposal would be important here in identifying current knowledge and practice of methodology and places where research was active.

APPENDIX D: SUGGESTIONS FROM WORKING GROUP ON HANDBOOK

It was found suitable to have a handbook in two volumes.

Volume 1 would be of a somewhat more permanent type, with the suggested title "Gaming - Theory and Practice".

Volume 2 should be e.g., computer output from a data base, i.e., a clearing house, of all games (of operational type) gathered by IIASA. The games should be gathered in form of a questionnaire, filled in by the game constructors, indicating (besides name and address etc.) the subject area of the game, the type of model, type of decision, main technical factors (if computer type), e.g., language, core requirement etc. type of efficiency criteria involved etc.

The data base should also be usable directly for e.g., finding all games with a specific characteristic.

The main interest centered on Volume 1. It should be intended for a wide audience, i.e., game constructors as well as game users, e.g., managers, making it possible to evaluate gaming as an alternative to other methods of analysis (e.g., simulation).

The need for such a book was regarded as being great; especially due to the rapidly growing field and the insufficient coverage in existing literature.

The following main chapter headings were regarded as tentatively suitable:

I. Introduction with a historic survey.

II. Experience of gaming in different areas, noting both where successful and where failures; indicating, if possible, reasons for this.

Subheadings according to area, e.g.,:

a. military games
b. international relation games
c. national economic planning games
d. local planning games
e. management education games,
etc.

III. Classification of games - a discussion of taxonomy (taxonomies)

IV. Terminology - definition of concepts of gaming.

V. Development of a Theory of Gaming

This most important chapter would be subdivided into e.g.,

a. Rigid form gaming
b. Free form gaming
c. Conclusions from gaming
each with their own subdivision, e.g.,

Under a) rigid form: stochastic processes; aspects of programming etc.
Under b) free form: heuristics; behavioral science aspects; etc.
Under c) conclusions: relation to simulation models; experimental manipulation of gaming variables; etc.

VI. Bibliography

It was stressed that this bibliography should be the best one available and that many areas well covered in the literature should not be repeated in the book, but the reader should be directed towards the most suitable reference.

As regards the actual writing, it appeared suitable that several authors participated even on single chapters (e.g., chapters II and V). The work would hence require an editorial board, consisting of 3-4 editors with an editor-in-chief.

It was suggested that the workshop elect such a board. Prof. Martin Shubik was unanimously proposed to be Editor-in-Chief.

APPENDIX E: GAMING - PROBLEMS OF THEORY AND PRACTICE

V.I. Marshev

INTRODUCTION

In recent years, interactive simulation (gaming), has become a popular method in:

(1) the education of managers;
(2) operational managerial decision-making, and
(3) theoretical studies of managerial problems.

The following article will discuss:

- successes, shortcomings and problems in the use of this method in the areas indicated above;
- opportunities in the development of the theory of gaming;
- the current stage of Soviet studies in this field;

1. DEFINITION

Let us specify the terms "the method of gaming" and "management game". The method includes the design and use of management games for education, teaching and training of managerial staff, for research into the problems of management, and for solving concrete managerial problems.

The management game is:

(1) a model of interrelated business (or economic) situations, presented in a dynamic sequence;
(2) a set of participants in the game;
(3) a set of symbolic actions by the participants according to the goals and the rules of the game.

The result of participation in the game is the dynamic sequence of decisions made (Figure 1).

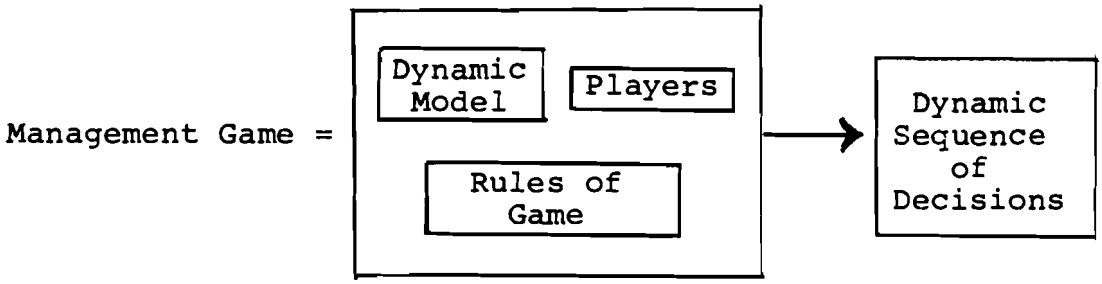

Figure 1. The elements of the simulation game

The management game as a model of the system of management reflects the following points:

(1) the structure of the organization modelled;
(2) the environment within which the organization and its administrative body are functioning;
(3) the set of possible solutions (decisions) available to the administrative body;
(4) the set of situations which arise as a result of the previously made decision, actions taken, and random circumstances which do not depend on the will of the administration.

The managerial game itself is defined by a system of rules (or status of the game). This system is represented by the instructions for the players and the instructions for the organizers of the game.

It is clear from these definitions that the method of gaming differs from the theory of von Neumann and Morgenstern and their followers. To settle this difference, the two terms used in English and American literature are used, namely, "gaming" and "game theory".

2. BRIEF HISTORY AND AN EXAMPLE OF MANAGERIAL GAMING IN THE USSR

The first managerial games were developed in the USSR in 1935 and were devoted to the development of habits necessary for the prevention and resolution of accidents at power stations.

The first business game to educate students in high schools was developed in the USSR in 1935. However, later on this work was cancelled, mainly due to the absence of the large technical devices required.

The appearance of computers again aroused interest in managerial games. The first managerial game on computer was designed in the USA in 1956 by the American Management Association (AMA). Despite the interruption in the development of managerial games in the USSR, the main principles of the first games are of interest today and were used further for the designing of the new games.

Let us give an example of a managerial game. The managerial game enterprise department simulates the activity of some branch of industry which consists of the department and 10 enterprises subordinate to it. The roles in this game are the following:

- Minister (Head of Department);
- 2 Deputy Ministers, Directors of the Enterprise and their deputy directors (one to each).

The game consists of several periods. The general task for the participants is to compose the annual plan of production and the plan for production flows between enterprises. All information needed is given to the participants on a definite set of blanks.

The enterprises compose an annual plan with a 3 month division according to the initial data: known demand (for a whole department) for separate items of production and their own possibilities for extending production. After the plan is composed (the time for this is limited) and recorded on a special blank, the director presents the plan to the department.

After receiving all the enterprise plans, the department assembles the figures into a definite form (on another blank) and the limits of resources which have been exceeded for the whole department are revealed.

In addition, the department solves the following questions:
- redistribution of production orders among enterprises;
- final attachment of users to suppliers; and
- redistribution of bank credits (the sum of which is limited) among enterprises.

As a result of all this, recommendations to the enterprises are produced. These recommendations include changes in the items and volume of production in comparison with the initial plans.

The recommendations are then discussed with the directors of the enterprises. As a result of this discussion, the final plans of the enterprises and the department are formed. After that the plans are considered carried out and the period of the game is finished.

In the next period the demand, the production facilities, and other parameters change according to the decisions made in the previous period. The process is repeated. The number of periods is up to the organizers.

The given model, like all other models, is simplified in comparison with reality. However, the description of the activity of the enterprise does take into consideration the main points of the recent Soviet economic reform (the enterprises form their own funds for material stimulation, they report to the department on certain sets of figures, they use bank credit for extension of their production capacity, and they also use their own funds for such extension).

At present, several hundred managerial games have been designed in the USSR, simulating different aspects of the socio-economic system. Dozens of scientific organizations are working now in the field of managerial gaming. The list of books in this field includes hundreds of volumes. However, the theory of management games which could serve as a basis for

classification of the management game and could offer regular methods for the design and use of management games in education, training, research and for solving different problems, has not been created yet.

In turn, the absence of such a classification makes it difficult:

(1) to understand the essence of the game;

(2) to understand the interrelations between games, and

(3) to choose the most suitable game for given conditions.

In the following paragraphs, an attempt is made to formulate the elements of a theory of managerial games (TMG).

3. ELEMENTS OF THE THEORY OF GAMING

From the phenomenological point of view, the management game is a model. This model reflects to some extent the different sides of socio-economic systems of different complexity and on different levels. This model also represents the system of the symbolic actions and interactions of the participants according to the given status of the rules, the goals of the game and the set of behavioral norms (which are familiar to the participants from their experience or from the literature).

The main idea in the theory of the management game is to consider the management game from a semiotic point of view, i.e. from the point of view of:

(1) its mathematical structure (syntax of the management game);

(2) interpretation (semantics);

(3) design and use (pragmatics of the management game).

Let us now discuss these parts of the theory of management games.

Structure

Practically every game is defined by its regulations, i.e., by its list of rules. In this list one must distinguish the list of syntax rules, the internal regulations of the game which describe the game by itself independent of interpretations and its design and use in special cases. This list of rules also defines the game as a mathematical object. The list of rules consists of seven sublists according to the elements from which the game is constructed:

(1) A set of pieces (a set of things to play with). We will call "pieces" those things which the players manipulate. Examples of pieces in a management game might include production facilities, material and financial resources, etc.

(2) A game space. In the course of the game, we must somehow allocate the pieces in the space. Usually, this allocation is well defined by the rules. The exact places and the order of the allocation is described in the rules for the initial step and for the process of playing. Thus in the game not only the set of places for pieces is set, but also the relation between places. Let us name the set of places - "the game space" and the set of places together with the structure of this space the "scheme of the game space".

(3) A set of game positions. When players have a set of pieces put in a certain way, we say that they have a certain position in the game. Let us call a "position" the placement of pieces according to the scheme of the game space. In every game there are rules to describe two special subsets of the positions: a set of initial positions and a set of final positions. In these rules, the rules to finish the game are also included. Thus the third sublist of rules defines the positions of the game (initial, intermediate, final) and also the finish of the game.

(4) A manipulational set of the game. The fourth sublist of rules defines the possible moves or manipulations as transformations of the positions. Let us call the the set of possible moves the "manipulational set" of the game.

(5) Functions for evaluating the final position. With the help of the fifth sublist of rules, the functions for evaluating the final position and also other positions for each player and team are set.

(6) The sixth sublist of rules sets the number of places for players in the game.

(7) Finally, the seventh sublist of rules defines the role of the player in the game, namely, it defines the right to have a certain amount of pieces of different types with the positions taken by these pieces, the duty of the players for the sequence of moves, the obligation to fight in order to reach the personal goal in the game, and the right to have various sorts of information about the game. As usual, the access to information is defined for the player implicitly from the context of the game.

Interpretation of the Management Game (Semantics)

Under the interpretation of the game as a formal system, we will understand the multiple or simple "mapping" or correspondence between the elements of the game and the "elements" of some conceptual class of substantive areas. The elements of the substantive objects, substantive expressions, substantive predicates, etc.

The totality of the interpretations of the game as a formal system is called the semantics of the game. The semantics are set by a part of the rules in the external regulations of the game. A key term in the analysis of the semantics of simulation games as models of social systems, from our point of view, is the term "role".

A simulation game is firstly a symbolic representation of the role structure of the social system analyzed. The essence of the modelling is the analysis of the empirical and theoretical structure of the social system, which is the totality of the inter-related roles of the participants, and the standardized relations between these roles. This structure is reflected in the structure of the formal system of the game, which includes the roles of the participating teams and relations between the roles.

Up to now, such a one-to-one mapping in the TMG has not been developed. That is why we have now the following pseudo interpretational correspondence between the syntax elements of the game and real economic roles, objects and relations:

Simulation game	-	Social system
A player	-	A participant in a social system
A set of pieces	-	Resources of the participants
A game space	-	A set of places where resources are allocated
Manipulation of the players	-	The actions of the participants
A position of the game	-	The current social situation
Symbolic relations between players	-	The relations between the participants
The symbolic goal of the game	-	The subject of the interaction between the participants
The role of a player	-	The role of a participant
The "umpire" group	-	Non-personal elements of the social system (environment, chance)

The interpretation of the simulation game is called correct if each correct position of the game corresponds to a time description of the social system. The interpretation is called adequate if every position which corresponds to a true description of the social system can be reached from the initial position. These two properties of the interpretation of simulation games are evident analogues to non-contradiction and completeness in a formal system.

Pragmatic Elements in the Construction of the Management Game

The methodology and methods for the preparation, conduct and analysis of simulation games is called the pragmatics of the management game. Using the pragmatics, we can divide games (management games) into free-form games and rigid rule games.

The rigid-rule simulation game has a very formal set of regulations. Using these regulations we can make an algorithm for the right moves. There is a distinction between manual and computer-based rigid-rule management games.

A non-formal, non-rigid simulation game is called free-form. One must distinguish between pragmatic and syntactic elements in the construction of the management game. In rigid-rule games, we have both elements, while in free-form games the syntactic elements are largely not made explicit.

The following are the main pragmatic elements in the construction of the game:

(1) a team of players;
(2) a team of conductors;
(3) the format of the game;
(4) the materials for the game.

The team of players is the group which carries out the role of the corresponding participants in the socio-economic system. The team of conductors is a group which carries out the role of the environment and of other vital participants in the socio-economic system who are not directly represented in the game. The format of the game - in practice, management games are regulated by a certain list of rules for the conduct of the game and methods of reporting, which we will call the formats of the game. These formats will serve as a general term for the rules for presenting information together with the procedures for conducting both rigid-rule and free-form games.

The materials for the game are office equipment such as terminals, telephones, calculators, etc.

There are three stages in the design and use of the management game:

(1) preparation;
(2) conduct;
(3) analysis.

The stage of preparation includes the construction of the pragmatic elements of the game and the formal system of the game (if it is a rigid-rule game), the choice of a suitable game among the available games and its adaption to the proper goals, the planning of the game, and the instructions to the teams before each play of the game.

The real cases for the construction of the game are usually taken from the practice of managerial activity. The construction of the games supposes the fulfillment of the following sequence of actions and requirements:

(1) the concrete practical aim of the game must be defined;

(2) the object/objects for the game setting must be chosen (it can be a department, production unit, enterprise, division, machine, brigade, etc.) Here also we must define the addressee of the game and the level of administration which is simulated;

(3) for the design of the game, a group of people must be assembled;*

(4) this group must be acquainted in detail with the materials to be the base of the game. For the construction of the game it is vital to study the accumulated experience in the construction of similar games. Moreover, the concrete material must be theoretically reexamined from the point of view of management science, taking into consideration facts and activities which preceded the modelled event or phenomenon.

(5) the time interval, the time for decision making and implementation of the solution must be defined in the games. In the description of the game we specify several things: the resources of the participants, the boundaries of their activity, the rules for the moves and for evaluation of the positions.

(6) those facts which are independent from the positions of the game are specified too.

(7) the instructions for the players and conductors are composed.

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*For the construction of the game it is reasonable to bring in specialists in management, economics, mathematics (programming), psychology, education and others, as well as the practical field being modelled.

(8) the initial information for the starting scenario which is necessary for the beginning of the game is designed (books of facts, figures, schemes of information flows).

After the instructions have been given out, the teams have received their portfolios, and after the players have been acquainted with the initial information, the play of the game starts. The start of the first round is declared. The play goes according to the previously specified scheme and can be generally presented as a process of receiving, analyzing, generating and transmitting information within teams and among them.

The analysis of the management game includes analysis of the process simulated, analysis of the play of the teams, and the work of the conductors, analysis of the pragmatics of the game, and exposure, analysis and improvement of the elements in the construction of the game.

It should be mentioned once more that the inadequacy of gaming as a scientific research method is determined by the incompleteness of the semantics. As a result, such problems as validity and verification of the solutions of the game are not solved.

4. CLASSIFICATIONS OF MANAGEMENT GAMES

The above-discussed elements of the TMG permit us to outline a list of the classifications of the management games. The management games developed are distinguished according to the following characteristics:

(1) The structural elements of the game: the several-person games; with opposite or the same interests; with numerical or ordinal functions for evaluating the players' positions.

(2) The procedures and means of conducting the game: free-form and rigid-rule games (manual and computer-based);

(3) The subject of simulation: structure of the economy; level of production; stages in a production process, etc.

(4) Purpose: educational, research, operational - practical. It is extremely important from the viewpoint of both theory and practice, to determine the place of a game in the classification. Let us demonstrate this with the above-mentioned example of the management game "Department - Enterprise" (Table 1).

Table 1.

CLASSIFICATORY INDICATORS	MGT. GAME "DEPT. - ENTERPRISE"
I Structural elements of the game	- Several-person game - Game with opposite interests - Game with numerical functions for evaluating the player's positions
II Procedure & methods for conducting the game	- Rigid-rule game - Computer-based game
III The subject of simulation	
- place of the object	- industry
- level of the object	- branch
- stages of production	- does not apply
- structure of the elements & parameters of the production process	- volume and quality of the product, production management
- stages of management	- planning
- level and functions of the managerial staff	- top and middle-level line managers
- methods of management	- economic, organizational
IV. Purpose of the game	- Educational

Let us elucidate the third, and from our point of view, most important indicator in the classification. The common indicators for all games from the view point of their contents are:

(1) The place of the simulated object in the structure of the economy (industry, agriculture, transport, etc.)

(2) The level of the object (economy, branch, production unit, enterprise, division, etc.)

(3) The stages of the "public production process" (including actual production, supply, sale, financing)

(4) The structure of the elements and parameters of the production process (staffing, technology, products, productivity of labor, capacity, quality, etc.)

(5) The stages in production management (goal setting, forecasting, planning, organization, administration, analysis, evaluation, control)

(6) The level and functions of the managerial staff (line and functional managers at top, middle and low levels).

(7) The methods of management (econmic, social, organizational etc.)

5. THE FIELDS OF APPLICATION OF THE MANAGEMENT GAME

In order to improve management, the gaming method is used in three areas - educational, research, and operational/practical - with corresponding functions in each.

I. The Educational Area (management training)

(1) demonstrational function: games are used as a means of demonstrating the concepts, principles, methods and ways in management.

(2) Training function: games are used as a means for training, for developing managerial skills, for teaching methods of problem solving.

(3) Motivational function: the games are used as a means to involve a person in the educational process and provide natural motivation.

(4) The function to improve activity: here games are used as a method for active education, for its activization and intensification.

II. Research Area - the formulation of management theory:

(1) heuristic function;
(2) verificational function;
(3) formalizational function;
(4) organizational function

Among the research functions we can really carry out only the organizatinal one, which is done during the process of designing and using the management game. In this process, it is possible to divide and coordinate in the system the labour of scientists, specialists and managers. As a result of the participation in

games, the theoretical research is done. This research takes much labour but is also very important, and for this reason it exceeds the psycho-physiological limits not only of the individual researcher, but also of the total number of researchers who are cooperating in the design and use of management games.

III. Operational Practical Area - the rationalization of management

(1) Analytical function: analysis of the elements of the concrete system of management (organizational structure, staffing, decision making and decision implementation process methods of management, managerial techniques, etc.)

(2) Planning function: The design of various elements in the management system.

(3) Experimental function: experiments with the developed elements of the management system under game conditions.

From previous experience we can conclude that the gaming method can be successfully used in studies of the following applied problems:

- studies of the management process;
- methods of influence on the various objects of management;
- the problem of short-term planning;
- the problem of forming the organizational structure of the object of management;
- the problem of division of functions and agencies within the management system;
- the decision making process and the implementation of the decisions on macro and micro levels;
- problems of global modelling;
- problems of modelling in international relations, etc.

6. CURRENT WORK IN THE USSR ON GAMING

In the USSR, the number of organizations and specialists engaged in the design and use of the management game is increasing constantly. The largest among them are: the Leningrad Financial Economic Institute (LFEI) - group of specialists led by Professor I. Sproezhin,- the Moscow State University (MSU) - the group led by Drs. V. Marshev and V. Efimov, the Institute of Management Problems (IMP) of the Academy of Sciences of the USSR - Prof. V. Burkov, the All Union Institute of Systems Research of the

State Committee for Science and Technology (ISR) - Professor Danilov-Danilian, the Academy of Foreign Trade (AFT) - Professor G. Vishnya, the Novosibirsk State University - Dr. F. Bozodkin, the Rostov Research Institute of Accounting - Dr. A. Gorstko. Let us now describe the experience of gaming in these organizations.

The LFEI is constructing a series of games in which the distribution of limited resources between the executors of large-scale national economic tasks is simulated (Games "ASTRA", "APOS", "LOTOS" and so on). Also, in this Institute, scientists are constructing a series of games in which diverse hypotheses related to the economic mechanisms of branch management are simulated and verified (Games "IMPULS", "NAUTILUS" and so on).

In Moscow State University, games are being constructed which simulate the activity of a union of enterprises (Games "Milk", "Auto-ZIL") or a big region (Game "Region - Tomsk"), or which simulate the mechanism of the formation of organizational structures and different hypotheses about the improvement of managerial methods (Games "Enterprise", "Branch"). Besides this, we are now constructing a management information system on which a series of small educational games "MIS - MG" will be based.

In the IMP, a management game is being constructed to simulate the process of management in hierarchical systems with different degrees of centralization and to compare their efficiency (Game - "Centralization of Management"). Also in this Institute, a game to analyze and demonstrate the mechanism of material stimulation in the management of socio-economic systems has been constructed (Game - "The Stimulation of Production Activity). In ISR a big game to simulate (on the national level) the influence of technological progress, to compare extensive and intensive management policies, and to study mechanisms for equalizing the growth rates of the different regions of the USSR is being constructed now. Also, Professor Milner's group is constructing a methodology for the use of gaming in the formation of various organizational structures.

In AFT (in collaboration with MSU and New York State University) a game is being constructed to simulate international trade negotiations and the negotiations for building joint US-Soviet enterprises. In MSU, games to simulate the process of management in a territorial production complex in Siberia (Game - "Sajana") and to simulate the process of forming plans with the use of a set of models (Game - "ASPR") is being constructed.

In RRIA, the regional game, "Agriculture" has been constructed, reflecting the process of realization of an agricultural production plan. In this game, several problems are solved: the choice of strategies for resource utilization, the production of products, taking into account the climate and other stochastic influences, and distribution and consumption of the end product.

Most of the games indicated here are being used with success as educational tools in Universities and in Institutes for the improvement of managers' qualifications in our country. The use of gaming as a decision making and research tool so far is less successful. Several books and text books have been published in the USSR on gaming. Two All-Union Seminars have been conducted in recent years, and at the last one (January 1978, in Leningrad, with about 80 participants), several new games were demonstrated. Soviet specialists have also taken part in the annual CMEA seminars on gaming.

APPENDIX F: MANAGEMENT GAMES IN POLICY ANALYSIS AND DESIGN (A HUNGARIAN EXPERIMENT)

L. Mőzes

At the Karl Marx University of Economics in Budapest decision games have been applied in the education and practical training of management since 1972. On the basis of the educational conception developed since then, a system consisting of three games is taught to about 400 students as a compulsory subject during two terms. However, this paper will focus on the application of a complex game as an economic laboratory. The game is the Hungarian version of a computer assisted decision game, used at New York University. This was altered, with financial support from the Ford Foundation and assistance from New York University in 1971-1972, to suit the needs of Hungarian economic conditions.

Since our game is a considerably developed version of the Carnegie Tech Management Game, only some extensions and modifications require presentation.

The four markets included in the Carnegie Tech Management Game were given features better corresponding to Hungarian economic conditions; they became foreign markets. Thus the enterprises of the Hungarian version of the game can sell their products not only on the domestic market, but also on the markets of the socialist, capitalist and developing countries - naturally under different terms.

Already the New York University Management Game contains a very detailed and well-structured accounting-financial system. On the basis of this we succeeded in developing a system corresponding to Hungarian regulations.

Naturally, the data base of the game had to be revised in detail in order to develop a consistent system of indicators characteristic of Hungarian enterprises.

Using the Hungarian version of the game, several management training courses were organized in 1972-1973, where real enterprise leaders of medium and high level, respectively, participated; the members of the Board of Directors were leaders of directing organs; the bank was represented by real staff members of the Hungarian National Bank.

On the basis of comparative analyses of the results of the game, the aggregate data of real enterprises, and the opinion of the active participants of the training courses, we saw that our game might be suitable for the examination of certain problems arising in domestic economic practice. These were problems connected with the economic regulatory system that was built into the model.

On the basis of this experience we began to deal with the application of our management game as an "economic laboratory"; that is, we transformed it into a tool for experiment, something not previously found in economic work. It was focused on some planned modifications of the system of economic conditions, which had not yet been carried out in practice. In this way, these modifications could be tried and eventual deficiencies or non-planned effects could thus be predicted. This application of the management game had two further aspects.

1. Expected enterprise reactions to the modified conditions could be assessed, since we let practising enterprise leaders with a well-grounded professional background, make the decisions in the game.

2. The game might help in making the period required for the adjustment of management to the new conditions shorter. Management could, by using the game, which was very similar to reality, get acquainted with the system of conditions and hence learn to adapt themselves. This in turn would decrease the economic losses connected with the time of adjustment.

Let us next describe the changes of the system that were contemplated.

A basic principle of Hungarian economic management control is that regulation has to be continuously, and in a planned way, adjusted to the dynamically changing reality for each plan period. Therefore there were already in 1973 in Hungary some ideas about the modification of certain elements of the system of economic control and management. These were discussed in various fields of economic and social life. Some of the factors discussed at the time were the following.

-- Previously, enterprises had to pay a charge on assets on the basis of the gross value of a part of their fixed and circulating assets. The modification planned was that a higher charge on assets (5 instead of 3%) should be paid after the net value of the assets engaged.
-- Another planned modification was that rates and taxes to be paid to the state after the wages paid would be raised by about 10 per cent in order to stimulate enterprises to a more economical labor management.
-- Previously the profits formed with the enterprises had to be divided into (1) a sharing fund that could be distributed among the workers and employees, and (2) a development fund to be spent on the development of the enterprise. The division was made according to a compulsory formula and taxes had to be paid on profits in a prescribed way. The planned modification was that a part of profits formed with the enterprises would be withdrawn automatically. It would then be up to the enterprises to determine the size of the sharing and development funds according to taxation pattern depending on the size of the funds.
-- Several other questions had also been raised, e.g., credit terms, export subsidies, etc. which could partly be taken into consideration when transforming the game.

The aim and character of these planned modifications made it obvious from the very start that the new conditions would have different influence on the further development of enterprises with different compositions of capital. Therefore, the three enterprises in the game were "established" in such a way that their capital composition was also different.

After due preparations, the game was played with enterprise leaders, staff of directing organs and financial experts and the following problem areas were examined.

1. Costs structure and price development in enterprises with different value compositions:

   -- development of the proportion of charges on wages and assets;
   -- effect of the changed rates and taxes on wages and charge on assets as well as the effect on the development of incomes left with the enterprise;
   -- effect of the charge on assets computed on net basis on shadow costs in view of the development of depreciation and investment;
   -- development of production costs, profitability and price effects.

2. Questions connected with the modified system of taxation on profits of enterprises with different value composition:

   -- effects resulting from changing the taxation on enterprise profits;
   -- development of budgetary payments in the present and the changed regulatory systems;
   -- development of enterprise behavior as regards wage development and the formation of the profit-sharing fund due to the changed regulatory system;
   -- enterprise behavior when determining the proportion of sharing and development funds;
   -- expected conflicts between the enterprise management and the workers' union as regards profit distribution;
   -- effect of the new regulation on the profit requirement of enterprise investments.

Examination of the above problem areas by means of the game proved successful. Certain effects were verified by the results of other investigations, while some others by real economic phenomena during the two years since the introduction of the new regulation.

Application of the games for such purposes has, of course, its limits. However, I think the results of experiments outlined above prove at all events that game models adequately developed may be useful complements in the domain of economic analysis.

APPENDIX G: A REVIEW OF GAMING ACTIVITIES IN JAPAN

Y. Osawa

INTRODUCTION

Just after the publication of Andlinger (1958) and Ricciardi (1957), various kinds of business games, developed in the United States, were transformed into Japanese versions and subsequently used among managers and students. At that time, in collaboration with Professor Totaro Miyashita of the University of Tokyo, the author also utilized this new educational tool and developed several types of games (e.g., Oswasa 1962; Osawa and Miyashita 1961). The last one developed (the Top Management Decision Game - Model 625-B) has been played, under our control, on about 100 occasions during a 15 year period.

One new development of gaming in the United States in the 1970's, dealing with social phenomena, was noticed by researchers in the field of engineering in Japan. Professor Tomitaro Sueishi, Faculty of Engineering, Osaka University, and his group, have made a continuing effort in developing gaming for analyzing the garbage treatment problems in urban areas (Sueishi 1977, 1978). Professor Yoshinobu Kumata, Faculty of Engineering, Tokyo Institute of Technology, and his group, have been concerned with nuclear plant construction and highway construction (Kumata, et al. 1975, 1976), using experimental gaming techniques.

In this review article, the gaming activities of these two groups are first briefly summarized. Then some findings from our experiences on the educational use of business games are presented. This is not, however, a comprehensive survey of gaming activities in Japan. Some commercial institutions are offering businessmen opportunities of participating in business

games in order to refresh their managerial abilities. As regards gaming as an aid in policy formulation, the research work has, I may say, just begun here in Japan.

GAMING EXPERIMENT ON ENVIRONMENTAL PROBLEMS

Professor Sueishi and his group, under the sponsorship of the Institute for Systems Science, has been concerned with garbage collection and treatment problems (including wastes emitted by factories) in urban areas since 1976 (Sueishi 1977, 1978). In the first year, they investigated the actual circumstances of the garbage collection and its treatment in some cities, surveyed the development of gaming methodology and its practice in the U.S., and then tried several gaming experiments, using the preliminary version of their simulated garbage system. Last year, the revised version of the gaming model was applied to the actual situation in Hiroshima and two experiments were carried out in which some personnel of the municipal office played the parts.

The last gaming exercise concerned the following roles: (1) the mayor of the city, (2) headmen of the neighboring rural areas, (3) inhabitants of the city, (4) inhabitants of the rural areas, (5) inhabitants around the garbage treatment plant, (6) representatives of manufacturers located in the city, (7) garbage collectors, and (8) employees of the garbage treatment plant. Six hours of gaming allowed for 10 rounds of play.

First a set of rules and a short scenario describing the initial situation as regards the city's garbage treatment were presented to the players by the gaming operator. Alternative courses of action from which each player could choose were specified in advance to the players. These courses of action were based on the study of various publications and interviews. The operator generated some events, both spontaneous and intentional, in each round. He also assigned the priorities with which each player could respond to a given event. The player with the highest priority then chose some action from his list of actions, and stated the motives of his behavior. Other players could respond to him in turn. Flow of money and amount of garbages moved and treated were presented on a chart board. At the end of the round, each player was then asked to report to the operator on how he evaluated the actions taken by the other players and on his level of consciousness about the garbage problems in the city.

After ten rounds of play, the records on communication flow between the interest groups, the mutual expectancy, the conflicts that occurred and had been resolved, etc., were analyzed in detail. Throughout the gaming exercise, there was a tendency for discrepancies of recognition on the garbage problems in each group to become wider whenever a concrete plan was proposed.

Sueishi and his group concluded that gaming methodology might be helpful for building a new social system based on mutual understanding. More specifically, the participants of the gaming experiment could learn what kinds of issues were involved in the problem, how different the value judgments and behavioral patterns of each group were, why such wide discrepancies of recognition of the issues involved arose, etc. It was concluded that if more people had opportunities to join the gaming experiment, it might be helpful for setting up a new social system in which mutual understanding would be formulated through information disclosure, hearings, participation of inhabitants in policy formulation, etc.

The approach to the environmental problems using the gaming experiment by Professor Kumata and his group was entirely different. They thought that the development plan of the new power system and the developing program of the specific new plant should be regarded as a separate function or the latter as a subsystem of the former. In their framework of analysis, the power company set up a goal regarding the amount of power to be supplied and specified the development plan of the new power system based upon this goal. Then, in accordance with the company's plan, a developing program would be formulated and come into operation. It might bring about some action and counteraction by the subjects concerned. Communications and influences between the subjects, including the power company, could be recognized as constituting a decision-making process relating to the power plant construction. The company would have alternative developing programs. If the company's programs, as well as the actions taken by the subjects concerned, would be regarded as the input into the decision-making process, the output could then be compared with input in order to choose the optimal program for the development plan of the company. Whenever the output was unsatisfactory, a new developing program should be generated or, when necessary, the development plant itself must be modified.

Kumata designed the gaming model in which the decision-making process of the subjects concerned was simulated in order to evaluate the alternative developing programs. His first approach was concerned with a nuclear power plant construction problem. A preliminary survey was conducted of the recent cases of power plant construction in three different locations. The following roles were specified: (1) the Minister in charge, (2) the governor of the local government (prefecture), (3) the head of the city concerned, (4) the leader of the opposition, (5) the representative of the power company, (6) three types of representatives of the inhabitants, (7) landowners, (8) fishermen, (9) the press, and (10) public opinion. It was assumed that each subject had his own objectives and was asked to optimize specific functional forms representing these objectives. Actions to be taken by the subjects, constituting influence and information, were determined by the field survey results and by records that had appeared in newspapers and magazines.

Sixteen participants joined the gaming experiment and five of them played the role of public opinion. One period of the experiment was divided into five steps, and in the first three steps communications among the subjects were exchanged. In the fourth step influences were generated, and in the final step, the present situations were explained to all the subjects by the gaming operator. About 20 minutes were needed to play one period, which corresponded to three months in the real world. Four alternative programs by the power company were operated in turn, with some repetitions.

The performance of each program was evaluated and compared multi-dimensionally using the following items: number of periods required to start the field operation of the plant construction; cost to the power company (including opportunity cost due to the delay of schedule); incremental utility of the local inhabitants; stability of the political power of the central and local government; cost paid for the dispute by the residents; etc. It was found that the program which disclosed the development plan to the public in earlier periods brought about a more desirable outcome in general.

Kumata's second paper dealt with a highway construction problem. Roughly the same framework was adopted as in the case of the nuclear power plant problem. Nineteen subjects were specified, and five alternatives were experimentally investigated. These programs were different with regard to whether an assessment of environmental changes was introduced or not, the time period when the inhabitants took parts in the schedule, and the communication pattern between the inhabitants and the local government.

As regards this problem, Kumata had the hypothesis that the decision-making process would produce a more desirable output when communicating patterns were well arranged. It was found from the gaming experiments that the assessment of environmental changes and its release to the public could remove uneasy feeling among the inhabitants towards pollution, and there were no significant differences concerning the starting periods when the inhabitants took part in the development. Finally, through an extensive hearing, a large amount of information could be communicated and it might be a useful means to achieve mutual understanding. He further noted that it was very difficult to identify the cause of variation of output in the different cases, since it might be brought about by differences in the developing programs, by the personality elements of the participants in the experiment, or by other random factors.

SOME EMPIRICAL FINDINGS FROM TOP MANAGEMENT DECISION SIMULATIONS

The Top Management Decision Game - Model 625-B was developed by Osawa and Miyashita in 1962 (unpublished) and has been played, under our control, repeatedly by top executives, middle managers

and candidates for managers in the leading companies in Japan. Over 3,000 businessmen have had experience with the game.

The essential points of the game can be summarized as follows: one product; one market; 4-5 companies without coalition; 4-10 participants for each company; no random element; different starting market shares and balance sheets. The items to be decided in each period are selling price, marketing expenditure, research and development expenditure, rate of production and investment for expanding production line for the next period, short and long term financing, dividend, capital increase, etc. One period corresponds to one quarter of a year. At the end of every year, the profit and loss account and the balance sheet of each company are announced by the gaming operator, while only selling prices and stock prices are disclosed in every period.

One of the main features of this gaming procedure is that each company is asked to respond to questionnaires delivered by the gaming director in the first period of every year. In the first questionnaire the participants are asked about their top management organization, their long range policy and planning, their management objectives and the quantitative measures expressing them, etc. The second questionnaire asks about the goals regarding market share, unit total cost, return on investment, size of plant, and amount of inventory. There are also questions regarding break-even points, optimal amount of inventory, pricing policy and optimum ratio of current assets to current liabilities. The third questionnaire is concentrated on how each company analyzes the behavior of the competitors by means of the published financial statements. Market shares, marketing expenditures, R&D expenditures and dividends of the competing companies must be projected here.

These questionnaires are designed in order to force the participants to use various kinds of management tools and ideas applicable to the decision-making process in the gaming situation. This device is most important in order to avoid rash and irresponsible decision-making and also to save the records of the original intentions of each company for later discussion. Neither good performance in the game nor the full educational effects can be brought about, it is believed, by the simple filling out of the figures on decision items.

Usually in the opening session, which starts in the evening in the common classroom, the gaming rules are explained, using a player's manual, for one hour, followed then by one hour's trial in order to avoid misunderstandings of the rules. After this session, the participants of each corporation are put into separate conference rooms where they are then required to establish a top management organization. The company's long range policies and plans for the next day's gaming are also to be discussed. Next morning the initial conditions are presented and the game commences. It continues for about eight hours. After dinner, the participants assemble in the common classroom again. Over twenty large graph charts, showing the performances of the individual companies, as well as the responses to the

questionnaires, are then displayed. Following the briefing of the information on these charts by the gaming director, the "general meeting of stockholders" starts. The president or chairman of each company describes the management policy, strategy and performance. Discussion continues for about two hours, and includes concluding comments by the referee.

Through this gaming exercise, the participants are expected to have obtained the following personal experiences: (1) It is generally very difficult to achieve both profit increase and market share position improvement at the same time. This is only achieved when the balancing between and timing of the dynamic and multiple decisions are well arranged. (2) One of the important factors affecting the company's performance is the coordinating function of its decision-making process. Leadership of the chairman is especially required when difficulties occur. Usually some good alternatives to overcome such situations are proposed by some members but subsequently phased out in the process of the discussions. It is not an easy job to incorporate the analytical findings based on data into the final decisions. (3) When a company tries to determine the cause of losing money, most frequently the outside reasons, such as the competitor's aggressiveness or economic depression surrounding the industry, are claimed. On the other hand, there is a tendency to conclude that a good performance results from the company's own efforts. Very often, these conclusions are not true. Failures by the competitors may improve a company's market position, and even in a bad economic climate an individual company may improve its position.

By developing new management games and operating them in practice, valuable experience has been gained. Firstly, without involvement of the participants in the game, the educational purposes of the game could never be achieved at all. The gaming director should behave like a director of a drama play. In the gaming described above, it is believed that none of the participants had a dull time throughout the long two day session.

Secondly, when a specific industry was simulated, and the employees of a company in this industry played the game, some difficulties arose. Players had a full knowledge about the circumstances of the industry, while all the elements concerning the industry were not necessarily involved in the simulation model. Sometimes the players wasted their time in discussing items not included in the player's manual. In the above mentioned management game, the type of product was, for instance, not specified.

Finally, it should be noted that the competent manager in the real world generally displayed his abilities in the gaming situation. It was also true that the players who were in higher positions in a company would almost always get a high rating in the game, and vice versa. Although it is frequently pointed out that one of the factors of success of Japan's business is the so-called bottom-up style management, this hypothesis would, it is believed, be true only in cases when able junior employees are commanded by a capable senior manager.

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